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Engineering Library

PUBLIC NOTICES

ASSISTANT LOCOMOTIVE SUPERINTENDENTS, INDIAN STATE RAILWAYS.

The Secretary of State for India will, in 1921, with the advice of a Selection Committee, make THREE APPOINTMENTS of ASSISTANT LOCOMOTIVE SUPERINTENDENTS for service on Indian State Railways, if so many suitable candidates present themselves.

Candidates must be British subjects, not more than 27 years of age, and must be of good moral character and sound physique. They must have had a good general and technical education, followed by at least three years' training in the locomotive workshops of a British Railway Company, or a locomotive builder of repute, and should have had six months' training in the running sheds and firing. A knowledge of applied mechanics and the nature and composition of all materials used in shops is essential, and applicants should be able to design and to calculate the stresses on the parts of the machines. Some drawing-office experience is also desirable.

Persons whose practical experience falls short of three years, but who have served in His Majesty's Forces during the war, will be eligible as candidates; but, if selected, will be required before appointment to complete satisfactorily such further period of training as the Secretary of State may prescribe.

Candidates may be required to appear before a Selection Committee at the India Office. They will also be required to pass a medical examination if selected for appointment.

The regulations in respect of the appointments and forms of application for use by candidates can be obtained on application to the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W. 1. Applications for appointment must reach the India Office not later than 15th November, 1921.

India Office,
22nd September, 1921. 6317

Civil Engineers Required by the GOVERNMENT OF THE TANGANYIKA TERRITORY for service as ASSISTANT ENGINEERS in the PUBLIC WORKS DEPARTMENT, for one tour of 20 to 30 months, with possible extension. Salary £500 a year for the first three years, thereafter rising by annual increments of £25 to £600 a year, paid locally in florins or rupees. A temporary local allowance at the rate of 50 per cent. of salary will be paid up to 31st March, 1922, and subsequently at the rate of 25 per cent. of salary, subject to review on 31st March, 1923. An outfit allowance of £30 will be paid on first appointment. Free single quarters and first-class passages provided. Liberal leave in England on full salary after each tour.

Candidates, under 35, preferably single, must have had practical experience as civil engineers on roads, buildings, and other public works, and preferably have passed the A.M.I.C.E. or other equivalent exempting examination.—Apply at once, in writing, giving age and brief details of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/Tang. 11,143. 6549

The Institution of Mechanical Engineers.
THOMAS HAWKSLEY LECTURE, 1921.

Dr. H. S. HELE-SHAW, F.R.S., Vice-President, will deliver the above Lecture on "Power Transmission by Oil" at the Institution, Storey's-gate, Westminster, on FRIDAY, 4th NOVEMBER, 1921, at 6 p.m.

Visitors are invited. 6514

PATENTS AND DESIGNS ACTS, 1907-1919.
ELECTRIC FURNACES.

The Proprietors of British PATENT No. 118,357 of 1917 are PREPARED to SELL the PATENT or to LICENSE British manufacturers to work under it. It relates to Electric Arc Furnaces in which an auxiliary electrode is adapted to serve in preliminarily heating the furnace.

Address: BOULT, WADE and TENNANT, 111/112, Hatton-garden, London, E.C. 1. 6538

Dorset Education Committee.
WEYMOUTH ENGINEERING AND JUNIOR TECHNICAL SCHOOL.

APPLICATIONS are INVITED for the POST of HEAD MASTER of the above-named School. Duties to commence on 1st January next. The duties will also include those of Organising Head Master of Further Education Classes in Weymouth and Portland.

Candidates must hold a good degree (or its equivalent) in Mathematics or Science.

Scale of salary (to which a 20 per cent. addition will be made), £400, rising by annual increments of £25 to £600 per annum.

Application forms may be obtained from
CLEMENT G. BONE,
Director of Education,
County Education Office,
Dorchester,
and must be returned to him completed not later than 9th November, 1921. 6525

Technical College, Bradford.

APPLICATIONS are INVITED for APPOINTMENT as HEAD of the DEPARTMENT of CIVIL ENGINEERING in the College.

A salary up to £700 per annum will be paid to a candidate of suitable qualifications and experience.

Full particulars of the appointment and forms of application may be obtained from the Principal of the College.

Applications to be returned so as to reach me as soon as possible.

N. L. FLEMING,
Town Clerk.
20th October, 1921. 6519

City of Leicester.
WATERWORKS DEPARTMENT.
CAST IRON PIPES.

The Water Committee of the City of Leicester invite TENDERS for the SUPPLY and DELIVERY of about 3700 Tons of 27in. diameter CAST IRON PIPES.

Conditions of contract, specification and form of Tender may be obtained by foundry companies or their agents from the undersigned.

Sealed Tenders upon the form supplied, endorsed "27in. diameter Cast Iron Pipes," are to be delivered to the undersigned on or before the 14th November next.

The Committee do not bind themselves to accept the lowest or any Tender.

G. T. EDWARDS, M. Inst. C.E.,
Water Engineer and Manager.

Waterworks Office,
Bowling Green-street, Leicester,
October 15th, 1921. 6460

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.

Naval Armaments and the Washington Conference.

The Future of Stainless Steel.

American Oil Pipe Lines.—No. IV.

Recent Developments in Power Station Design.—No. XIV.

New Method of Making Concrete Roads.

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The Commercial Motor Exhibition.

Low Temperature Carbonisation of Coal.

Scientific and Industrial Research.

The Metallurgical Chemist.

PUBLIC NOTICES

East Indian Railway.

The East Indian Railway Company is prepared to receive TENDERS for the SUPPLY and DELIVERY of:—

(1) WROUGHT IRON PIPING, &c.;
(2) LAMPS, &c., AND GLASS;

as per specifications to be seen at the Company's offices.

Tenders are to be sent to the undersigned, marked "Tender for W.I. Piping," or as the case may be, not later than Eleven o'clock a.m. on Wednesday, the 9th day of November proximo.

The Company reserves to itself the right to divide the order, also to decline any Tender without assigning reasons, and does not bind itself to accept the lowest or any Tender.

For each specification a fee of £1 1s. is charged, which cannot under any circumstances be returned.

By Order,
G. E. LILLIE,
Secretary.

Nicholas-lane, London, E.C. 4,
26th October, 1921. 6554

The Great Indian Peninsula RAILWAY COMPANY.

The Directors are prepared to receive TENDERS for the SUPPLY of the following STORES, namely:—

No.		Fees for Specification.
1.	POINTS AND CROSSINGS, &c.	10s.
2.	TIE BARS, GIBS AND COTTERS	10s.
3.	STEEL FISH BOLTS AND WASHERS	7s. 6d.
4.	FENCING MATERIALS	10s.
5.	FENCING WIRE STRAND	10s.
6.	GALVANISED WROUGHT IRON WATER TUBES, &c.	7s. 6d.
7.	RAIL LIFTERS, &c.	5s.
8.	WATER CRANES	7s. 6d.
9.	ACID OPEN-HEARTH STEEL BOILER PLATES	7s. 6d.
10.	GALVANISED CORRUGATED SHEETS	10s.
11.	METALS, &c.	10s.
12.	LEATHER BELTING, &c.	£1
13.	WOOD HANDLES	7s. 6d.
14.	PLATELAYERS' TOOLS	10s.
15.	PAINTS, DRYSALTERIES, &c.	£1
16.	MALLEABLE CAST IRON BRACKETS	2s. 6d.

Specifications and forms of Tender may be obtained at this office on payment of the fee for the specification, which payment will not be returned.

The fee should accompany any application by post. Cheques and postal orders should be crossed and made payable to the Great Indian Peninsula Railway Company.

Tenders must be delivered in separate envelopes, sealed and addressed to the undersigned, marked "Tender for Points and Crossings, &c.," or as the case may be, not later than Eleven o'clock a.m. on Tuesday, the 8th November, 1921.

The Directors do not bind themselves to accept the lowest or any Tender.

R. H. WALPOLE,
Secretary.

Company's Offices,
48, Copthall-avenue, E.C. 2,
London, 26th October, 1921. 6555

The Ministry of Public Works, Egyptian Government, are calling for TENDERS for the SUPPLY of PUMPING PLANT and MACHINERY to be erected by the contractors at Atf.

The plant to include 4 Diesel or semi-Diesel engines, each directly coupled to a turbine or centrifugal pump, with all necessary pipes, &c.

Conditions of Tender and specification, price 10s., can be obtained from

THE INSPECTING ENGINEER,
Egyptian and Sudan Governments,
Queen Anne's Chambers,
Westminster, S.W. 1. 6400

PUBLIC NOTICES

Metropolitan Water Board.
SUPPLY OF 42IN. AND 48IN. STEEL TUBES.

The Metropolitan Water Board invite TENDERS for the SUPPLY of:—

(a) Approximately 155 FEET of 42in. LAP-WELDED STEEL TUBE (the final riveting of field joints to be done "in situ"), for the crossing of River Lea at Lea Bridge.

(b) TEN 16ft. and FOUR 6ft. Lengths of 48in. LAP-WELDED STEEL TUBES, for the Walton to Honor Oak Main.

Forms of Tender, conditions of contract, &c., may be obtained on personal application at the offices of the Board (Room 150), New River Head, 173, Rosebery-avenue, E.C. 1, or will be forwarded on receipt of a stamped addressed envelope.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for Steel Tubes," must be delivered at the offices of the Board not later than 11 a.m. on 11th November, 1921.

The Board do not bind themselves to accept the lowest or any Tender.

W. MOON,
Clerk of the Board.

New River Head,
173, Rosebery-avenue, E.C. 1,
21st October, 1921. 6530

Metropolitan Water Board.
SUPPLY OF 48IN. CAST IRON PIPES, &c.

The Metropolitan Water Board invite TENDERS for the SUPPLY of approximately 9000 TONS of CAST IRON PIPES and SPECIAL IRREGULAR CASTINGS (British Standard Specification) required in connection with the Walton to Honor Oak Main, Section No. 2 (Maiden to Clapham Park).

Forms of Tender and conditions of contract, &c., may be obtained on personal application at the offices of the Board (Room 150), New River Head, 173, Rosebery-avenue, E.C. 1, or will be forwarded on receipt of a stamped addressed envelope.

Tenders, enclosed in sealed envelopes, addressed to "The Clerk of the Board, Metropolitan Water Board, New River Head, 173, Rosebery-avenue, E.C. 1," and endorsed "Tender for 48in. Cast Iron Pipes," must be delivered at the offices of the Board not later than 11 a.m. on 11th November, 1921.

The Board do not bind themselves to accept the lowest or any Tender.

W. MOON,
Clerk of the Board.

New River Head,
173, Rosebery-avenue, E.C. 1,
21st October, 1921. 6537

SITUATIONS OPEN

WANTED, ENGINEER, with Extensive Practical experience, capable assisting Chief Draughtsman in Superintending Lay-out and Design of Refrigerating Plant (land installations).—Address, 6535, The Engineer Office. 6535 A

A YOUNG ENGINEER, with a Sound Knowledge of Design of Air Compressors, to Take Charge of a Small Department and work same up under his own control. This represents an excellent opening to a qualified man.—Address, 6563, The Engineer Office. 6563 A

AN INSPECTOR is REQUIRED to Supervise the Concrete Work in the Lining of a Tunnel in Yorkshire. The weekly hours will be 48, but they will be irregular and partly spent at night. The job will probably last two years, and there is a possibility of extension. Applicants should write, stating pay required, and enclose two recent testimonials not later than Novenber 7th next.—Address, 6540, The Engineer Office. 6540 A

SITUATIONS OPEN (continued).

ASSISTANT CIVIL ENGINEER REQUIRED for Argentina, preferably with experience of Dock Construction; well up in instrument work; age 27-30; salary £600 per annum and first-class passage.—Write, stating full qualifications, age, training, and experience, with copies (only) testimonials, to Box "E. B. P.," c/o Davies and Co., 95, Bishopsgate, E.C. 2. 6515 A

CHIEF ENGINEER REQUIRED by Well-known Firm of Light Car Manufacturers in the South. Must be thoroughly conversant with latest practice in the design of light cars, both from production and road users' point of view, also of drawing-office and production routine. Good organiser and systematic.—Send full details of training, experience and previous positions held, and remuneration required, to "CHIEF ENGINEER," c/o Kenneth Brown, Baker, Solicitors, Lennox House, Norfolk-street, Strand, London, W.C. 2. 6524 A

CIVIL ENGINEER.—ASSISTANCE REQUIRED in Westminster.

1. Fully qualified ASSISTANT, experienced in Outfall Sewers, Sewage Disposal, and Pumping.

2. DRAUGHTSMAN, with experience in similar work.

Address, stating age, experience, and salary, to P4291, The Engineer Office. P4291 A

ENGINEER FOR CEMENT WORKS.—WANTED, a CONSTRUCTIONAL and OPERATING ENGINEER in India, to Superintend Erection and Maintenance of Cement Mill Machinery, Rotary Kilns, and Power Plants. Salary offered up to Rs. 650 per month, according to qualifications, with free quarters, light and fuel. Three years' agreement with first-class passage out and home. Good prospects for suitable man.—Apply by letter only, with copies of testimonials, &c., to TATA, Limited, Capel House, New Broad-street, London, E.C. 2. 6543 A

EXPERIENCED MACHINERY SALESMAN REQUIRED for important position in connection with modern workshop equipment.—Address, 6550, The Engineer Office. 6550 A

FIRST-CLASS, All-round, Expert MACHINE TOOL DEMONSTRATOR WANTED for South America. Knowledge of Spanish desirable. State age, experience, and salary required.—Address, 6530, The Engineer Office. 6530 A

FIRST-CLASS MACHINE TOOL REPRESENTATIVE REQUIRED for Birmingham Branch. Essential qualifications include:—Thorough engineering training, expert knowledge of modern American machine tools, experienced in salesmanship, highest personal character.—Apply in writing to BURTON, GRIFFITHS and CO., Ltd., 76, Vauxhall Bridge-road, London, S.W. 1. 6556 A

REQUIRED, ASSISTANT to MANAGING DIRECTOR of Engineering Firm; engineering and commercial experience essential and good address. Candidates please state salary required, age, &c.—Address, 6544, The Engineer Office. 6544 A

REQUIRED for New Zealand, a Thoroughly Competent ENGINEER to Take Charge of a Gum Digging Plant. Only thoroughly practical Persons, energetic and capable and possessing best of references, will be considered. A great opportunity for a brainy, hardworking man.—Full particulars, salary, &c., to HENRY MILLER and CO., Trinity Chambers, Trinity-square, London, E.C. 3. 6260 A

SALES MANAGER REQUIRED IMMEDIATELY for a Firm of Engineering Agents holding a number of high-class exclusive agencies, North of England and Scotland, to Take Full Charge of Sales Department, Head and Branch Offices and Travellers; must be first-class commercial man; guarantee required; remuneration by salary and commission on gross turnover.—Address, P4290, The Engineer Office. P4290 A

SUPERVISING ERECTING ENGINEER WANTED for Firm in the North. Applicants must have had experience in the Erecting, Wiring, and Running of Large Rolling Mills and other classes of Electrical Apparatus.—Address, with particulars of training, age, experience, and salary required, 6496, The Engineer Office. 6496 A

WORKS MANAGER for Scottish Steel Foundry.—Must be energetic, up-to-date and thoroughly experienced in modern foundry practice. Knowledge of steel making not essential. Applicants should send full particulars of their experience and state age and salary expected.—Address, P4257, The Engineer Office. P4257 A

WORKS MANAGER WANTED by a Well-known Firm of Light Car Makers in the London district. Must be a good organiser, producer and thoroughly experienced in the latest methods of economical works management.—Send full particulars of training, experience, previous positions held, and remuneration required, to WORKS MANAGER, c/o Kenneth Brown, Baker, Solicitors, Lennox House, Norfolk-street, Strand, London, W.C. 2. 6523 A

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WORKS SUPERINTENDENT REQUIRED by Manufacturers of Electric Accumulators, Midland counties. Must have good mechanical engineering experience and be accustomed to handle men. Knowledge of accumulator construction not essential.—Address, 6390, The Engineer Office. 6390 A

DRAUGHTSMAN REQUIRED, North-East Coast, for Structural Work and Bridge Work. Only fully experienced men need apply. Applications from juniors and improvers will not be considered.—Address, 6541, The Engineer Office. 6541 A

DESIGNER REQUIRED for Large Carriage and Wagon Works; must be fully qualified man, with initiative and originality.—Address, stating experience, age, and salary required, 6518, The Engineer Office. 6518 A

FIRST-CLASS FOREMAN ARMATURE WINDER REQUIRED; must have good all-round experience on A.C. and D.C. Windings of every description. Apply, stating experience, age, and salary. Only men who have occupied a similar position need apply.—Address, 6517, The Engineer Office. 6517 A

WANTED for Motor Car Repair Work, TWO thoroughly well-qualified MOTOR FITTERS, age 35-40; must have served 5 years' apprenticeship as engineers, must possess wide experience, be capable of doing all kinds of Motor Work, including Valve and Ignition Timing, Carburettor Adjustment, Tuning-up, &c., and one to have, in addition, good knowledge of Electric Starting and Lighting Sets.
References must prove above capabilities.
Address, P4292, The Engineer Office. P4292 A

BOILER ERECTORS REQUIRED for the East; must have experience in Erection and Running of various types of Water-tube Boilers. Age 30, single. Salary £400 upwards and free accommodation. Free passage. Three years' agreement.—Write, stating age, full particulars of training and experience, giving dates, to Box A. P., c/o Regent Advertising Service, Ltd., 4, London Wall Buildings, E.C. 2. P4265 A

HYDRAULIC PRESS MAN REQUIRED for Works in Midlands, accustomed to Pressing Boiler Ends and general work; only one who thoroughly understands this class of work need apply. State age, wages, and experience.—Address, 6557, The Engineer Office. 6557 A

SITUATIONS WANTED

ADVERTISER, Having Held Positions of Works manager, supt. foreman, REQUIRES BERTH; experience in production of steam, oil and gas engines, car work, motor craft, &c.; first-class testimonials; good organiser; moderate salary.—Address, P4241, The Engineer Office. P4241 B

ADVERTISER (27), Graduate in Civil Engineering, good draughtsman, surveyor, ex-Army officer, keen and practical, SEEKS SITUATION at home or abroad.—Address, P4271, The Engineer Office. P4271 B

AERIAL ROPEWAYS, TELPHERAGE, GENERAL ENGINEERING DESIGNER and ERECTOR SEEKS POSITION. Excellent references.—Address, P4253, The Engineer Office. P4253 B

BUYING ENGINEER.—The MANAGER of a Large Engineering Works Purchasing Dept., who has an exceptionally wide knowledge of the markets of the country, DESIRES to NEGOTIATE NEW APPOINTMENT. Services will be available in two weeks' time.—Write, Z. M. 613, c/o Deacon's, Leadenhall-street, E.C. 3. 6534 B

COMMERCIAL ENGINEER, A.M.I.M.E., OPEN to suitable APPOINTMENT; 12 years' Indian experience; good knowledge of Spanish.—POOLEY, Bank House, Knutsford. P4274 B

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ENGINEER (31) REQUIRES PROGRESSIVE POSITION, Assist. Mechanical Engineer or Assist. Works Manager; 16 yrs. practical and theoretical experience of steel works' maintenance and internal combustion engine work.—Address, P4191, The Engineer Office. P4191 B

ENGINEER (35) SEEKS CHANGE as SUPERINTENDENT or similar responsible position requiring energy, initiative, and a wide experience in tool design and production methods for the manufacture of light electrical gear, telephones, &c.—Address, P4256, The Engineer Office. P4256 B

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Full particulars past results on application.—Address, 6550, The Engineer Office. 6550 B

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HEATING and VENTILATING ENGINEER (Working) SEEKS PERMANENCY on maintenance work; 18 years' practical knowledge on installations of high and low-pressure steam, vacuum, plenum, Nuvacuumette, Nuconomiser systems, &c., hot and cold water, gas, pumps. Age 36.—Address, P4273, The Engineer Office. P4273 B

HOT WORK, Up-to-date Methods.—POSITION of SUPERINTENDENT or HEAD FOREMAN REQUIRED; die sinking, stamping, smithing, machine forge work. Highest references. Good disciplinarian; M.F.M.B.—Address, P4255, The Engineer Office. P4255 B

KEEN, Energetic ENGINEER (37), with Full Commercial experience, WISHES responsible POSITION. Full knowledge buying, costing, sales, publicity, home and export; can take complete control and carry on successful development.—Address, P4206, The Engineer Office. P4206 B

LOCOMOTIVE and CARRIAGE ENGINEER (28), 5 years' training in loco. works of leading English railway, 6 years' experience in loco., carriage and wagon dept. of important Indian railway as assistant and district loco. superintendent, running dept. and workshops, including 3 years in charge of drawing-office, estimating, and indent department, DESIRES POST in England as DISTRICT or ASSISTANT LOCO. SUPERINTENDENT, ASSISTANT WORKS MANAGER, or similar responsibility. Very keen; A.M.I. Loco. E.—Address, P4254, The Engineer Office. P4254 B

MECHANICAL ENGINEER, 5½ Years in Workshops and drawing-office, SEEKS opportunity of gaining COMMERCIAL EXPERIENCE with engineering firm in Midlands; nominal salary.—Address, P4283, The Engineer Office. P4283 B

MECHANICAL ENGINEER, 13 Years' Good General experience as manager and foreman, also costing and travelling, SEEKS responsible POST, any capacity.—Address, P4118, The Engineer Office. P4118 B

SITUATIONS WANTED (continued)

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YOUNG ENGINEER, G.I. Mech. E., 24, Shops and drawing-office, steam and electric haulages, pumps, REQUIRES URGENTLY POST as ASSISTANT to CONSULTING ENGINEER.—Address, P4268, The Engineer Office. P4268 B

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DRAUGHTSMAN, 14 Years Mechanical Engineering and detail design, technical and practical railway work, now OPEN to receive APPOINTMENT.—Address, P4277, The Engineer Office. P4277 B

DRAUGHTSMAN (20), with 2½ Yrs. Drawing-office and 3 yrs. works experience and good education, REQUIRES SITUATION.—50, St. George's-road, Coventry. P4286 B

DRAUGHTSMAN (21) DESIRES SITUATION Anywhere; experience in general engineering lay-out and details, also jigs and tools; quick, neat and accurate.—Address, P4223, The Engineer Office. P4223 B

MECHANICAL DRAUGHTSMAN, with Wide Experience in the design and lay-out of various industrial plants, power station design, &c., DESIRES SITUATION; City office preferred.—Address, P4282, The Engineer Office. P4282 B

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EX-SERVICE MAN (29), Single, 3 Years' Apprentice railway, 4 years brassfoundry, I.C.S. draughtsman diploma, SEEKS SITUATION, home or abroad.—Address, P4289, The Engineer Office. P4289 B

WORKING ENGINEER WANTS WORK; 7 Years shop, 7 years sea, B.O.T. certificate; first-class refs.; A1 mechanic, any type of machinery.—Address, P4284, The Engineer Office. P4284 B

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Established seventy years.

WAKE UP, ENGLAND! We Have the Goods: a Small Article with World Monopoly. Works, tools, offices, large orders, production and commercial experience. We require £500; 10 per cent. interest will be given. A salaried position equal to £1000 per annum. Mass production; output guaranteed in 14 days.—Address, P4288, The Engineer Office P4288 C

EDUCATIONAL

CORRESPONDENCE COURSES for B.Sc., Inst.C.E., I. Mech. E., and all ENGINEERING EXAMINATIONS. Special Courses and Single Subjects. Personal Tuition.—Mr. TREVOR W. PHILLIPS, B.Sc. (Hons.), Assoc. M. Inst. C.E., M.R.S.I., &c., 8-10, Trafford Chambers, 58, South John-street, Liverpool. Ex.

EXPERT TUITION BY CORRESPONDENCE In Mathematics, Mechanics, and Machine Drawing.—Mr. J. CHARLESTON, B.A. (Hons. Oxon and Lond.), 14, Elsham-road, Kensington, London, W.14. P4179 E

HOME STUDENTS.—London Matriculation, B.Sc. and A.M.I.C.E. Exams. During studies difficulties arise. Correspondence courses are expensive and possibly you only require occasional individual explanations. We offer you these. Send stamp for particulars.—CONSULTUTORS, 60, Abingdon-road, Kensington, London, W. P4293 E

INST. C.E., Inst. Mech. E., B.Sc., and all ENGINEERING EXAMINATIONS. — Mr. G. P. KNOWLES, M.B.E., B.Sc., A.M. Inst. C.E., &c., personally PREPARES CANDIDATES, either orally or by correspondence. Thousands of successes during the past sixteen years. Courses can be commenced at any time.—39, Victoria-street, Westminster, S.W. Telephone No., Victoria 4780. Ex.

LEARN SURVEYING AND LEVELLING. — Thorough practical instruction given by an expert. —Address, E. MOUL (late L.S.W. and S.P.D. Rlys.), Hollybank, Woking. P4133 E

TUITION BY POST.—Inst. C.E. and I. Mech. E. Enrol now for next Exams.; 100 per cent. Passes last examination. Estab. 1878.—PENNINGTONS University Tutors, 254, Oxford-road, Manchester. Ex.

MISCELLANEOUS

WANTED, Progressive FIRM with Large Selling Organisation, to undertake the MANUFACTURE and SALE under licence on royalty basis to us of PATENTED ARTICLES to help children of all lands by eliminating school drudgery (casting and press or press work only). No competition. The unlimited scope should give employment to a large number of workers.—Particulars, "DARNLEY'S," 190, Stockwell-road, London, S.W. 9. 6522 I

A FIRM that has been Developing an Important and valuable machine is DESIROUS of MAKING an ARRANGEMENT with a large firm in order to have increased MANUFACTURING FACILITIES and ASSISTANCE in SELLING on a mutual basis.—Address, P4226, The Engineer Office. P4226 I

CATALOGUES, TECHNICAL PAPERS, INSTRUCTION MANUALS, &c.
Manuscript Prepared by Experienced Engineer. Expert in the preparation of Technical Literature. Enquiries Solicited.
F. JOHNSTONE-TAYLOR, B.Sc., etc., The Bungalow, Underdale Road, SHREWSBURY.

AGENCIES

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Naval Armaments and the Washington Conference.

(By a Correspondent.)

THE approaching Conference at Washington on the subject of the limitation of naval armaments has arisen very largely out of the difficulty of financing the colossal naval programmes which the termination of the war found well in hand in Japan and the United States. Although it is as yet far from clear as to whether it will be confined to mere discussion of the subject or whether any decisions on the matter will be made, it seems not unlikely that any verdicts which it may formulate may tend to affect Great Britain and the Dominions to a greater extent than either of the original parties whose interests were considered to be at stake.

Like most grave questions, the problem with which the nations are now confronted, and to deal with which the Conference has been convened, is not by any means one of recent growth, nor, unfortunately, is it one that has been free from very serious strife in the past. For the real fact is that the object of the Conference is less, at heart, the question of naval armaments than a compromise which will obviate the recurrence of troubles in the Pacific. Now it is an indisputable historical fact that no two great national fleets have so far occupied the same seas without eventually coming to blows, and, though in this case we can console the pessimists with the fact that San Francisco and Yokosuka are some five thousand miles apart, they can retaliate, if they choose, with some startling statistics regarding the growth of naval armaments, for which the only parallel is found in our own case during the four years prior to 1914. We feel fairly certain that very few people in this country realise that, since Great Britain in 1916 left off building capital ships, for the double reason that during the war she was short of men and since it because she is short of money, Japan and the United States together have authorised and laid down *no less than one million tons of capital ships*, or roughly double the tonnage of ships of the Dreadnought and post-Dreadnought types built for the German Navy. How many realise that the tonnage of the United States capital ships built and being built is to-day *just 50 per cent. greater than the corresponding British total*, and will still be about 25 to 30 per cent. greater when the orders for the four new British ships are placed? If we exclude the Hood, the United States Government has laid down *since the beginning of* 1917 battleship and battle-cruiser tonnage *equal to the total British capital ship tonnage* from the Orions to the Repulse. Japan has laid down about half this amount, and to-day, taking only ten-year-old ships, the displacement tonnage of the three navies built and under construction stands as follows:—

	Tons.
United States	1,088,600
Great Britain	709,950
Japan	576,920

Sixty per cent. of the other navies' totals was laid down *since the Hood was begun*. In the accompanying table the annual growth of the three fleets is shown, and from it will be seen how the British programmes were speeded up just prior to 1914—a stroke of foresight on the part of the Admiralty which should lead to proper appreciation of its action during the years 1917–1921. Fuller comparisons are unnecessary, but a very significant feature of United States policy has been the provision, on a very large scale, of fleet colliers, oilers and auxiliaries which it is impossible to indicate here. The Pacific Ocean covers magnificent areas—it is over 8000 miles from the Panama Canal to Manila—and fleet operations are correspondingly increased in difficulty. Perhaps it is partly for this reason that the growth of these navies has been somewhat ignored; similar energy in Europe would have started a panic long ago![*]

Comparative Table of Capital Ships.

Year of laying down.	Great Britain. Vessel.	Year of complet'n.	Displacement.	Heavy guns.	Japan. Vessel.	Year of complet'n.	Displacement.	Heavy guns.	United States. Vessel.	Year of complet'n.	Displacement.	Heavy guns.
			Tons.				Tons.				Tons.	
1909	Orion	1912	22,500	10–13.5in.	Settsu	1912	20,000	12–12in.	Utah	1911	21,800	10–12in.
									Florida			
1910	Thunderer								Arkansas	1912	26,000	12–12in.
	Conqueror								Wyoming			
	Monarch											
	Lion		26,350	8–13.5in.								
	Princess Royal											
1911	King George V.		23,000	10–13.5in.	Kongo	1913	27,600	8–14in.	New York	1914	27,000	10–14in.
	Centurion	1913			Hiyei	1914			Texas			
	Ajax											
	Audacious*											
	Queen Mary*		27,000	8–13.5in.								
1912	Iron Duke	1914	25,000	10–13.5in.	Fuso	1915	30,600	12–14in.	Oklahoma	1916	27,500	10–14in.
	Marlborough				Haruna		27,600	8–14in.	Nevada			
	Benbow				Kirishima							
	Emperor of India											
	Tiger		28,000	8–13.5in.								
	Queen Elisabeth	1915	27,500	8–15in.								
	Warspite											
1913	Barham				Yamashiro	1916	30,600	12–14in.	Pennsylvania	1916	31,400	12–14in.
	Valiant	1916										
	Malaya											
	Ramillies	1917†	25,750	8–15in.								
	Resolution	1916										
	Revenge											
1914	Royal Sovereign				—	—	—	—	Arizona	1916	31,400	12–14in.
	Royal Oak											
1915	Renown	1916	26,500	6–15in.	Ise	1917	31,260	12–14in.	Mississippi	1917	32,000	12–14in.
	Repulse				Hinga	1918			New Mexico	1918		
									Idaho	1919		
1916	Hood	1919	42,000	8–15in.	—	—	—	—	California	1920	32,300	12–14in.
	Anson	Cancelled										
	Howe											
	Rodney											
1917	—	—	—	—	Nagato	1920	33,800	8–16in.	Tennessee	1921	32,300	12–14in.
									Maryland	Complet'ng	32,600	8–16in.
1918	—	—	—	—	Mutsu	1921	33,800	8–16in.				
1919	—	—	—	—	—	—	—	—	Washington	—	32,600	8–16in.
									Colorado	—		
1920	—	—	—	—	Kaga	—	40,600	8–16in.	West Virginia	—		
					Tosa	—			*Battleships*‡—			
									South Dakota	—	43,200	12–16in.
					Battle-cruisers—				Indiana	—		
1921	Four "Hood" type authorised but not included in total.				Amagi‡	—	43,500	8–16in.	Montana	—		
					Akagi‡	—			North Carolina	—		
					Atago§	—			Iowa	—		
					Takao§	—			Massachusetts	—		
									Battle-cruisers¶—			
									Lexington	—	43,500	8–16in.
									Constellation	—	—	—
									Saratoga	—	—	—
									Ranger	—	—	—
									Constitution	—	—	—
									United States	—	—	—

Totals Available and being Built.

Battleships	21	11	25
Battle-cruisers	6	8	6
	27 = 700,950 tons	19 = 576,920 tons	31 = 1,088,600 tons

* Lost in war; not included in total. † Completion delayed by accident in launching. ‡ Authorised in 1919. § Authorised in 1920; precise date of laying down uncertain. ‖ and ¶ Three of each authorised in 1917 and three of each in 1918, but commencement delayed. The United States Navy Department has recently officially stated the degree of completion of these vessels on August 31st last to be as follows:—Battleships: South Dakota, 34.1 per cent.; Indiana, 31.2 per cent.; Montana, 27.3 per cent.; North Carolina, 36.5 per cent.; Iowa, 29 per cent.; Massachusetts, 10.4 per cent. Battle-cruisers: Lexington, 24.2 per cent.; Constellation, 13.3 per cent.; Saratoga, 27.4 per cent.; Ranger, 2.5 per cent.; Constitution, 10.7 per cent.; United States, 10.4 per cent.

AMERICA IN THE PACIFIC.

Now there are several aspects regarding the bid for naval supremacy on the part of the United States which makes it a very interesting study. Great Britain, at least, whose Navy to-day is materially stronger than that of all the fleets of Europe combined—not, incidentally, a novel position—can afford to view the United States naval expansion with absolute complacency. Unlike the late German and Russian navies, it does not exist for purposes of aggression, nor when the total armaments are considered in relation to the position, size and wealth of the country, can the American navy be considered disproportionate. One or two fundamental facts about the United States stare the world in the face. The size of their navy at any time during the last twenty years at least has been limited solely by the amount of money that they were *willing* to spend on it; in that way it is unique. A rich self-contained nation with a population exceeding one hundred millions can easily afford a fleet out of all proportion to a nation half the size, and had it not been for the geographical distribution of the individual States in the Union America might long since have had a naval force second to none for size and cost. A number of the most thickly populated States are far inland, and their representatives in Congress have hitherto consistently preferred to see national expenditure devoted to such purposes as the improvement of inland waterways, &c., and their influence was, until the entry of the country into the war, sufficiently strong to keep the navy at a more moderate strength in proportion to the current needs of the nation. A much bigger Navy Vote than that actually allotted was repeatedly put forward in bygone years, but the influence of the inland element as often prevented its acceptance. But the tremendous demonstration of the value of the naval command of the sea which the whole world witnessed during the Great War, led the United States during its closing years, while in the flood-tide of prosperity and perhaps before the likely cost was fully appreciated, to set out on a programme of capital ships which would give them a fleet second to none in the world. To suggest that this fleet was built for aggression in any quarter of the world is completely to misunderstand United States history. Strategically the country is in a very awkward position—far worse even than Germany was prior to the making of the Kiel Canal. From Hampton Roads to San Francisco *viâ* the Panama Canal is fully 5000 miles; by rail the journey takes a week. To maintain complete naval supremacy in both Atlantic and Pacific Oceans simultaneously is beyond the financial ability even of the United States, and though the Panama Canal is a wonderful waterway, it is amazingly vulnerable. It is impossible to forget that over twenty big landslides blocked it as many

[*] The reader may be referred to Mr. Hector Bywater's "Sea Power in the Pacific" (Constable and Co.), a volume which discusses with great frankness and lucidity the possibilities of a war between Japan and the United States.—ED. THE E.

times during its first year's operations, the last occasion at Culebra closing it entirely for many months. One cannot object to a nation with two seaboards many thousand miles apart taking precautions which would seem excessive for only one.

If we go back over the history of the Pacific Ocean, or rather over that of the nations bordering upon it, we see at once that size alone and the distance that separates them from one another has prevented warfare on the relatively continual scale that the Mediterranean has witnessed. Except for the British conflict with Spain on the West Coast of South America, which endured practically without real cessation from the sixteenth to the eighteenth centuries, there was no serious fighting in that sea until the advent of steam propulsion. The acquisition of Australia and New Zealand was brought about by the peaceful penetration of uninhabited countries, the gold mines of the former being the greatest influence in this direction. European intrusion into the Far East did not take place on any scale until after the Napoleonic wars, although before then the Dutch had definitely lodged themselves in the large islands of the East Indies. No survey of conditions in the Pacific is complete without reference to these valuable colonies, and we note that Holland is to be represented at the Conference, as becomes the second largest European Power in the Pacific. Except for the presence of their whaling fleets in the neighbourhood of the Aleutian Islands, the United States had practically no maritime interests in that ocean until after the Civil War, when much original discovery work was conducted under Commodore Peary and Lieutenant (afterwards Rear-Admiral) G. W. Melville on the north coast of Siberia. The British expeditions to China in the 'sixties, where the United States were also represented, were relatively unimportant, and the real history of the Pacific, practically speaking, is of very recent date, commencing with the opening up of Japan, about seventy years ago. Trade with China through the treaty ports had been satisfactory in spite of temporary friction, and comparative peace reigned over the Eastern hemisphere until fate started the Russian Empire on its policy of eastward expansion. The germs of friction were already in the Far East when the construction of the Siberian Railway was first undertaken. Even in the 'eighties the commercial potentialities of Manchuria were hardly grasped, but the approaching threat of Russia in railway communication with Vladivostok put an entirely different aspect on the Pacific position. In all fairness to our Japanese allies, the history of the years between 1890 and 1905 should never be forgotten. What occurred in Corea during that period had an extraordinary reflex action on Europe in the years which followed.

Commercial relations between Japan and China and Corea were steadily increasing with the development of Japan from its wholly isolated and self-contained condition prior to the 'sixties, when the probability of Russian interference both in China and Manchuria as a result of the completion of the Trans-Asiatic Railway grew to an alarming extent. A definite foothold on the mainland became essential for Japan, which was rapidly becoming more and more dependent on overseas trade. A quarrel with China over Corea resulted in war between the two countries in 1894, and Japan found herself in a few months in possession of both Port Arthur and Wei-hai-wei. It was an interesting little war technically. For the first time the Whitehead torpedo was successfully used against a ship under steam, and the then newly developed Armstrong quick-firing gun was first employed in a naval action which resulted disastrously for the Chinese. Wei-hai-wei was handed back to China, but Japan proposed to retain Port Arthur, from which she was forced to withdraw by the combined action of Russia, Germany, and France. The seeds of war thus sown were destined to have a remarkable effect on international politics after a very short period. The Japanese as a nation grasped very quickly and clearly the fact that without an adequate fleet the commercial intercourse with the mainland, on which their existence largely depended, could not be maintained, and they set themselves steadily to work to procure a naval service. Events in Cuba at the other side of the world, which bore no relation whatever to Far Eastern affairs, brought about a war between the United States and Spain, which resulted in the transfer of the Philippines to American ownership and the eventual foundation of a United States naval base at Manila, only 1700 miles from Yokosuka. The seizure of Port Arthur by the Russians as soon as the Siberian Railway to Vladivostok was completed, and the construction of a branch line from Port Arthur to meet it at Harbin were a direct threat to Japan, which was gradually being excluded from Manchuria, where the Russians were making wholesale appropriations regardless of the Chinese. England acquired Wei-hai-wei on lease from China, and the Anglo-Japanese alliance was arranged to counter the Russian influence in the Far East. This fact is far from being properly recognised in the United States.

Influence of the Russo-Japanese War.

It was the interference of the Russians with Japanese trading interests on the mainland, and particularly on the borders of Corea and Manchuria, coupled with a long-developed mutual antipathy, that brought about the Russo-Japanese War of 1904–1905. Prior to its commencement all the newer capital ships of the Russian navy had been sent to the Far East on completion; simultaneously Great Britain built ship after ship for Japan. The result of the war was the extinction of the Russian navy, the loss of Port Arthur, which the Japanese captured and retained, the formation of a Japanese protectorate over Corea, and the firm establishment of Japan on the mainland. The reflex action in Europe was very marked. The eclipse of Russia as a great Power and the blow thus dealt at the Franco-Russian alliance encouraged the military development of Germany, a move which was countered by Great Britain by the application of the naval lessons of the campaign. The Dreadnought was the direct result of these. But more than that, the lesson to Japan, temporarily crippled as she was financially by the war, was the utter, absolute necessity of an adequate fleet for the preservation of her integrity. The whole *raison d'être* of Russia's navy had been the support it gave to her unscrupulous policy of acquisition in the Far East; except for the loss of a prestige which would never have been accorded had Europe been more accurately informed about Russian affairs, the destruction of the navy alone did little harm to Russia beyond encouraging Germany. To Japan the maintenance of a fleet is as vital as it is to the British Empire. The end of that war found Japan in a financial condition strongly resembling our own at the present day. A fleet was essential, but she could not afford more ships; fortunately, thanks to the alliance with Great Britain, she was not in any danger of attack. The rise of Germany following on the collapse of Russia focussed attention more and more on European affairs, while the Japanese were consolidating their gains and retrieving their financial position.

The next important step in the Pacific was the construction of the Panama Canal. During all this period Holland continued to reap vast benefits from its colonial possessions, and alike with Australia, New Zealand, and Canada, conducted its affairs in peace and prosperity. The weak spot in the Pacific lies in the state of China. Enormous, very heavily populated, rich, and with considerable natural resources, a strong China would be a stabilising influence of the utmost value at the present juncture. But always weak and disunited and preyed upon by internal dissensions which have often entailed foreign interference, China has been a bone of contention ever since 1800. The competition for concessions to develop portions of that country has been on an increasing scale since 1906, and it is the rush for trade opportunity in Asia that is causing anxiety. The opening of the Panama Canal brings the United States eastern seaboard and the manufacturing interests adjoining it into very much closer touch with Asia than they ever could have been otherwise. It does not particularly affect British seaborne trade because the journey to China and Australia is more rapidly accomplished *viâ* the Suez Canal. It does mean a considerable increase of Anglo-American competition in that part of the world; it means, moreover, a very great increase in American competition in those markets particularly necessary to Japan. Chinese imports average about eighty million pounds a year; her exports seventy millions. Great Britain is by far the largest customer, manufactured cotton goods predominating amongst the imports, and silk in various forms predominating amongst Chinese exports. Compared with other countries, about 45 per cent. of China's foreign trade has been with Great Britain in recent years; some 20 per cent. is with Japan, and 10 per cent. with the United States.

Economic Problems.

The great possibilities for development both in China and Manchuria are expected to figure largely in the discussions at Washington, which, it is anticipated, will largely centre round the questions of exclusive economic rights, leased territories, spheres of influence, and other problems contributing to international friction. To what extent the trade aspect will be regarded in order of priority in relation to the limitation of armaments is very uncertain. It is the latter which at the moment very closely concerns Great Britain. Now we have seen from the comparative table of capital ships authorised that the vast majority of the Japanese and United States recent programmes were authorised and partly undertaken long before the Treaty of Versailles came into being. The later years of the war found both countries unexpectedly rich; both, as we have seen, had fully appreciated the necessity of naval strength, the one from being an island, the other from having two seaboards separated either by Cape Horn or the faith they may have in the integrity of the Panama Canal in war time; both spent their surplus wealth on fleets. That either country deliberately built against the other we cannot believe from the sequence of events. The Versailles mandate which gave to Japan the custody of the Marshall, Caroline, and Marianne groups of islands, including the much-discussed cable island of Yap, was subsequent to the big Japanese Navy Law of 1918, and to the United States naval programmes of 1917 and 1918. The erstwhile separation of the two navies by the width of the Pacific has been reduced to a few hundred miles or more separating the archipelagoes which the two nations now control in the East Indies. Russia, as a factor in Far Eastern affairs, finally disappeared from the scene about 1917.

Lord Jellicoe's Report.

A move of very great importance was made about this time by Great Britain, although the European war was still in progress. Admiral of the Fleet Sir John Jellicoe, undoubtedly one of our ablest exponents of naval strategy, undertook the investigation of Australian naval affairs with special reference to the Pacific and their relationship to Imperial needs, and subsequently became Governor-General of New Zealand, a position which he still occupies. Admiral Jellicoe's report to the Australian Commonwealth was made in 1919, subsequent to the rearrangement of spheres of influence authorised by the Treaty of Versailles and subsequent also to the actual laying down of much of the recent naval construction. It is undoubtedly the latest survey on the part of a competent authority of British naval needs in the Pacific, and at a time when the limitation of armaments is under consideration, and any agreement to reduce them may relieve the financial burden, it is of particular interest to recall the opinions given. Lord Jellicoe stated that it was not possible to consider Australian defence without taking into account the naval requirements of the whole Pacific, and the Far Eastern naval problem concerned the whole Empire. The Australian Navy was likened to one faggot in a bundle. Neither Sydney nor Auckland, from their geographical positions, were fitted to be the headquarters establishment of the Far Eastern command, which for reasons connected with both the Indian Ocean and the China command should obviously be at Singapore. In the scheme of adequate defence of British interests in the Pacific we may look in vain for the phrase "limitation of armament." Canada, Australia, and New Zealand, India and South Africa alike are expected under the Jellicoe scheme to contribute their quota, the whole Empire sharing proportionately the cost on a basis of population and value of seaborne trade. On this scale the United Kingdom would contribute 74.12 per cent., Canada 12.8 per cent., Australia 7.74 per cent., South Africa 3.82 per cent., and New Zealand 2.02 per cent. The Indian contribution would be on a somewhat different basis. Lord Jellicoe reported that "it is considered that the naval interests of the Empire are likely to demand within the next five years a Far Eastern sea-going fleet of considerable strength. . . ." He based the composition of this fleet on a series of fleet units, one or more of which would be allocated to the various Colonies and supported *pro rata* thereby. Each fleet unit would consist of one battleship or battle-cruiser of the most modern type, two light cruisers, six torpedo-boat destroyers, four submarines, and two fleet mine sweepers. A fleet made up of such units was estimated to require as auxiliaries:—

For every 18 torpedo-boat destroyers ..	1 depôt ship
For every 9 torpedo-boat destroyers ..	1 flotilla leader
For every 8 submarines	1 depôt ship
For every 2 units	1 aircraft carrier
For every 8 units	1 repair ship
For every 16 units	1 minelayer

Australian naval defence was subdivided by Lord Jellicoe into three parts, consisting of (*a*) a striking force composed of one or more fleet units; (*b*) for direct defence of trade four light cruisers and eight armed escort vessels would be required, assuming that other portions of the Empire made provision on a similar scale; and (*c*) harbour defence, for which twenty torpedo-boat destroyers or "P" boats, ten submarines, eighty mine sweepers—of which seventy-four would be fishing trawlers—and four boom defence ships would be required. With these vessels would go bases and depôts in proportion. The Far Eastern fleet envisaged in the report was assumed to be composed of:—

8 modern battleships,
8 modern battle-cruisers,
10 light cruisers,
40 destroyers,
2 depôt ships for torpedo-boat destroyers,
2 flotilla leaders,
36 submarines (excluding those of India),
4 submarine parent ships,
2 aircraft carriers,
12 fleet mine sweepers,
1 large sea-going minelayer,
2 fleet repair ships.

This list appears more formidable than it actually is; many of the ships are already available. It is the larger capital units that are lacking.

Here we have a very carefully considered report on the necessary standard of naval strength which we should maintain in the Far East. The numbers exceed considerably even the fleets we maintained in Chinese waters, the East Indies, the Australian Squadron, and that on the West Coast of America in the early years of the century, when neither Japanese nor United States fleets approached their present numbers. Lord Jellicoe expressly provided that it was a series of squadrons, each operating in its own local waters under its own admiral and responsible mainly to its own Government, but meeting together at least once a year for exercises and manœuvres under the command of the Admiral Commanding-in-Chief, who was to be resident at Singapore. What influence will the verdict of the Washington Conference bring to bear on this scheme?

The four new British warships will not be affected, but it is not quite clear whether work is still actually proceeding on all the later units of the foreign programmes or if some are not in a state of temporary suspension. If so, there is less need for the programme in its entirety. At the present moment it would appear that it is those who have recently forced the pace that are first in getting tired of it.

Developments In Power Station Design.

No. XIV.*

For use where a supply of combustible gas is available and where it is required to generate electricity, the gas-fired boiler unit shown in Fig. 67 has been designed by Spencer Bonecourt, Limited. Units of this kind evaporate up to 42,000 lb. of steam per hour from and at 212 deg. Fah., when working on coke oven gas, or up to 32,000 lb. with producer or other gas of low calorific value, and with a suction in each case of 4in. of water. An arrangement of this sort occupies a space about 17ft. long by 18ft. wide, complete with feed-water heater, superheater and fan. In a power station requiring 120,000 lb. of steam per hour from and at 212 deg. Fah., when working at maximum load, four of these units fired with coke oven gas would do the work under easy steaming conditions. When working at their full capacity three units would suffice, so that in reality the fourth boiler would be a stand-by. The burner of these boilers is a very simple device. It consists of a flat box with the face nearest the tube plate perforated with holes, which are exactly opposite the centre of each tube. The gas inlet of the box is controlled by a single valve, which gives all the adjustment necessary. No explosive mixture or even primary air is admitted to the burner before combustion commences, as the gas jet gets its air for combustion after leaving the burner, and back-firing is said to be impossible at all speeds of the gas. In other words, the burner may work with the valve full open or with a mere speck of light at each of the outlets.

The amount of air is controlled by the suction fan, which is invariably driven by a motor with a speed regulator on the switchboard, and an adjustable damper is also fitted to the fan. In the case of natural draught boilers a damper is the sole controlling device. Perfect combustion is obtained by varying the suction to suit the particular gas pressure at any particular load. The gas and air particles cannot escape each other, as they are forced to mix intimately in the fire tubes. The absence of a fire box, combustion chambers and flues makes it impossible for gas to pass through the boiler without meeting and getting intimately mixed with air, and that is why no large excess of air is required for complete combustion.

The functions of the tube packing, which we have referred to in a previous issue, are as follows :—(1) It accelerates the mixing of the fuel and air, and consequently accelerates combustion of the mixture; (2) it transmits a proportion of the heat of combustion to the water by radiation, instead of by conduction alone, thereby accelerating the transmission of heat; (3) it prevents the hot products from passing down the centres of the tubes without coming into contact with the heating surface, and also prevents the formation of a cold inert gas or air film on the walls of the tubes; and (4) it increases the length of the path of flow of the gases and increases the heat-absorbing surface over which the gases sweep. By simply varying the length of the packing in each tube, the temperature of the gases leaving the boiler for the superheater or leaving the feed-water heater can readily be adjusted at any time after the plant has been erected. The average evaporation per unit of heating surface can, it is said, be increased to 400 per cent. above that corresponding to ordinary practice without the efficiency of the boiler being impaired. As the tubes are fed with water over their entire length, there is said to be no fear of priming or of the tubes being burnt out. Owing, moreover, to the rapid heat transference which takes place in and through the tubes, both by radiation and conduction, the average temperature over the packing varies from 680 deg. to 500 deg. Cent., whilst the maximum temperature attained for a short distance along the inlet end of the tubes rarely exceeds 850 deg. Cent. The suction fan pulls the gases through the tubes and over the packing at a sufficiently high velocity to ensure dust being carried right through. The power taken by the motor-driven fan varies from 1 to 3 per cent. of the output of the boiler, according to conditions. Boilers with an evaporation of 1500 lb. of steam per hour are now constructed to work on natural draught. The thermal efficiency is slightly lower than in the case of the larger units worked with mechanical draught, but, of course, a fan and motor are then unnecessary. The only chimney needed is a steel metal uptake from the fan, which has a length sufficient to clear the roof. This type of gas-fired boiler is suitable for working with any gaseous fuel, such as coke oven gas, producer gas, water gas, and, of course, town gas. Gas-fired boilers are sometimes classed as waste heat boilers, but waste heat gases are really those that have undergone complete combustion.

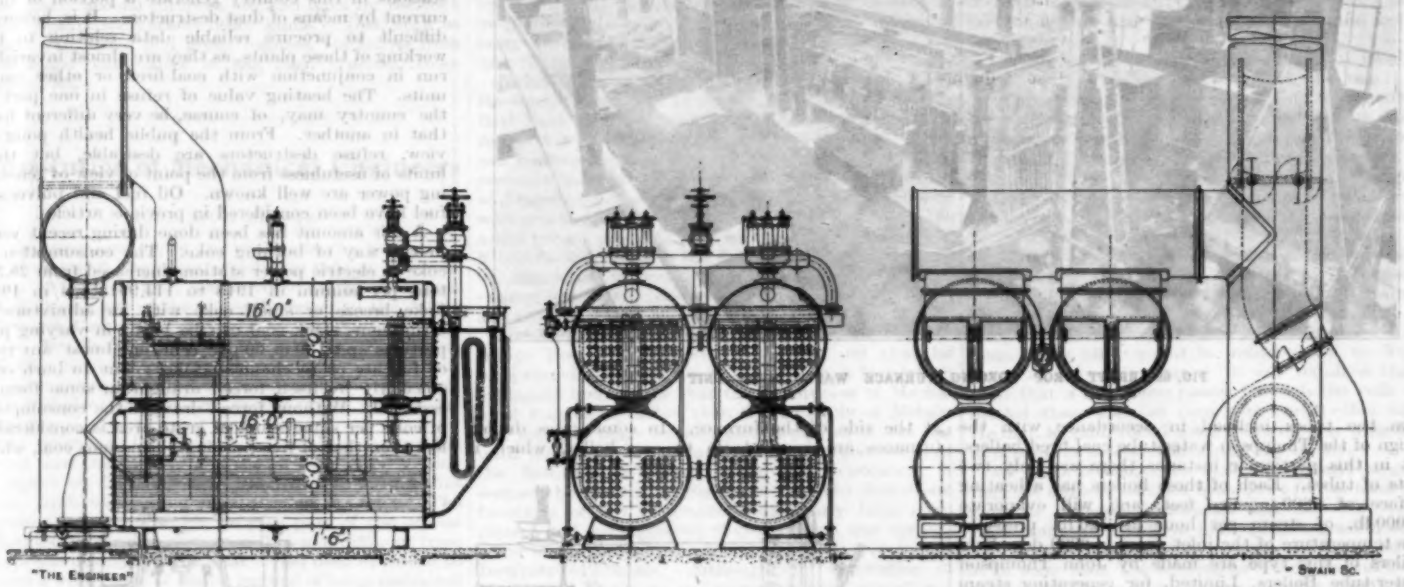


FIG. 67—A BONECOURT GAS-FIRED BOILER UNIT WITH FOUR DRUMS

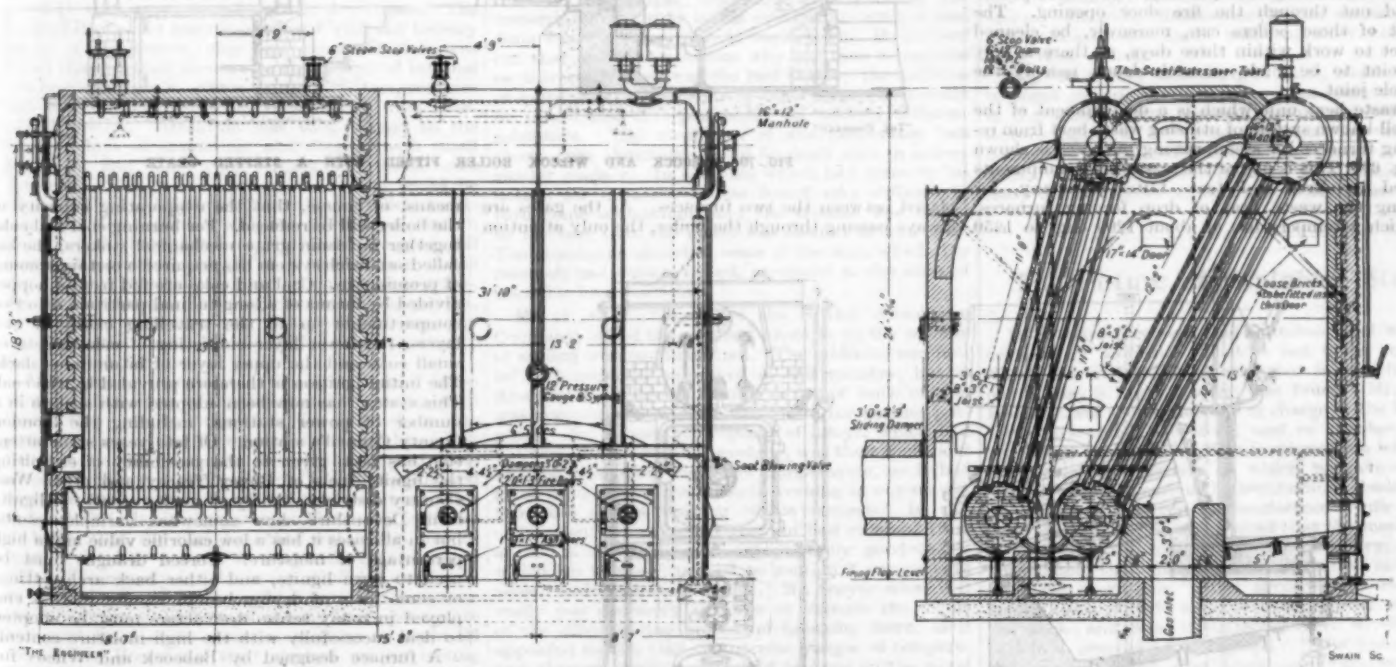


FIG. 65—TWO THOMPSON COKE-OVEN GAS BOILERS

* No. XIII. appeared October 14th.

Two Thompson boilers, which form part of a battery of five, operated with coke oven gas, are shown in Fig. 68. These boilers, it will be noticed, have the tubes inclined in accordance with the design of the Thompson water-tube coal-fired boilers, but in this particular instance there are only two nests of tubes. Each of these boilers has a heating surface of 4800 square feet, and will evaporate 14,000 lb. of steam per hour at 120 lb. pressure. The temperature of the inlet gases is 2000 deg. Fah. Boilers of this type are made by John Thompson Water-tube Boilers, Limited, for generating steam by the utilisation of waste heat from destructors, annealing furnaces, &c., and the amount of steam generated per square foot of heating surface depends, of course, upon the temperature of the gases passing over the tubes. One of the principal advantages of these boilers is that, as all the tubes are straight, it is merely necessary to stock one kind of tube having a length corresponding to that of the longest tube in the boiler. The boiler is suspended from mild steel girders resting on mild steel columns, which are independent of the brickwork. All parts are free to expand, and every part is easy to inspect and clean. No extra head room is required for renewing tubes, as any tube can be passed in and out through the fire door opening. The largest of these boilers can, moreover, be cleaned and set to work within three days, as there is only one joint to be made on each drum, namely, the manhole joint.

A waste heat unit which is a development of the old well-known system of utilising waste heat from reheating furnaces for steam-raising purposes is shown in Fig. 69. This is one of the waste heat equipments devised by Brett's Patent Lifter Company, for utilising the waste heat of drop forging furnaces, in which a temperature of about 1200 deg. to 1250 deg. cent. has to be maintained. Pyrometer tests show that the average temperature of the gases leaving these furnaces is 850 deg. Cent., and if this waste heat is allowed to pass up the chimney and out into the atmosphere, there is an obvious waste of fuel. To avoid this waste a boiler is placed on the top or at the side of the furnace. In some cases duplex furnaces are coupled up to one boiler, which is placed between the two furnaces. As the gases are always passing through the boiler, the only attention required is that involved in regulating the water, but in the case of the Brett waste heat units, an automatic feed-water regulator is provided. As the water level drops, a pump commences to work automatically, and the boiler therefore works continuously without any attention at all.

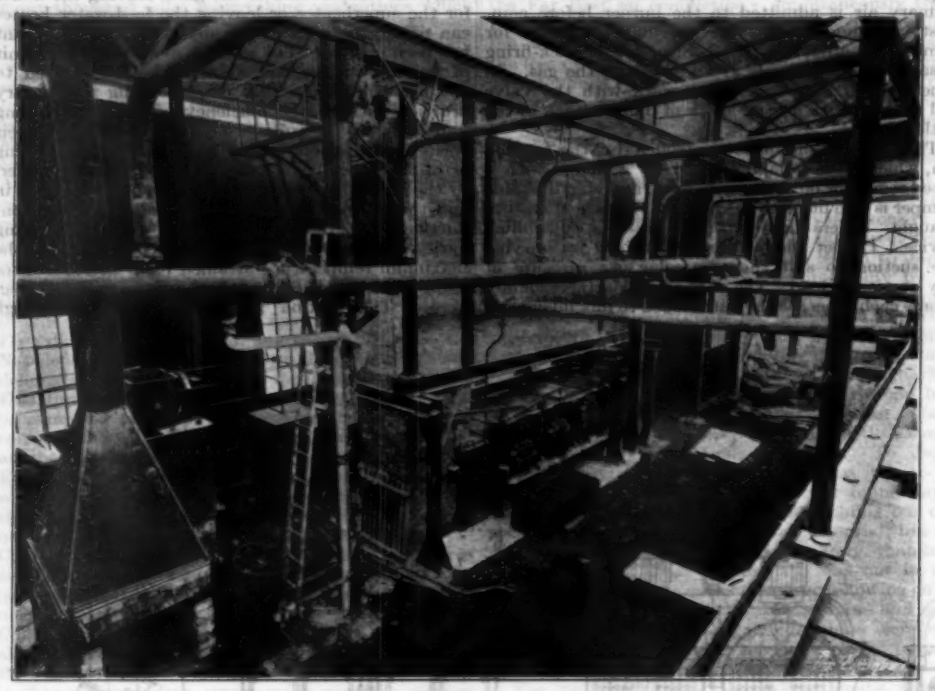


FIG. 69—BRETT DROP FORGING FURNACE WASTE HEAT UNIT

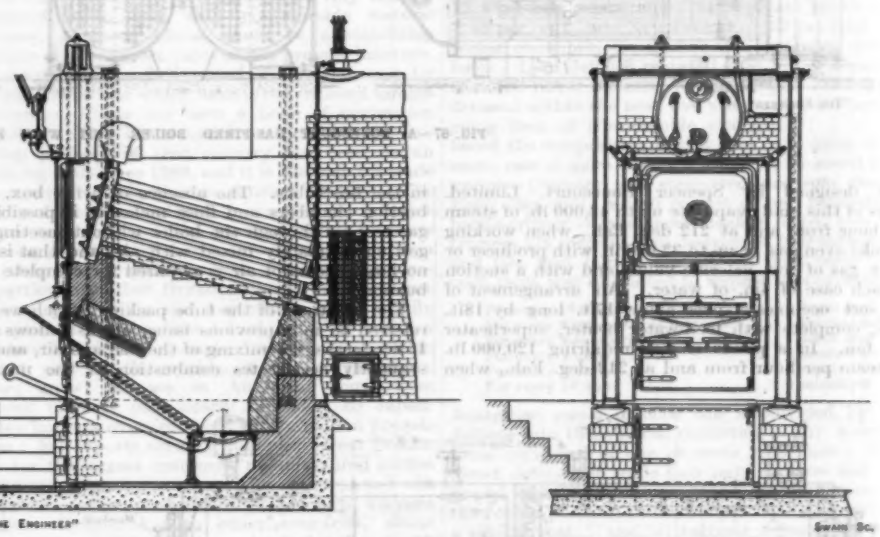


FIG. 70—BABCOCK AND WILCOX BOILER FITTED WITH A STEPPED GRATE

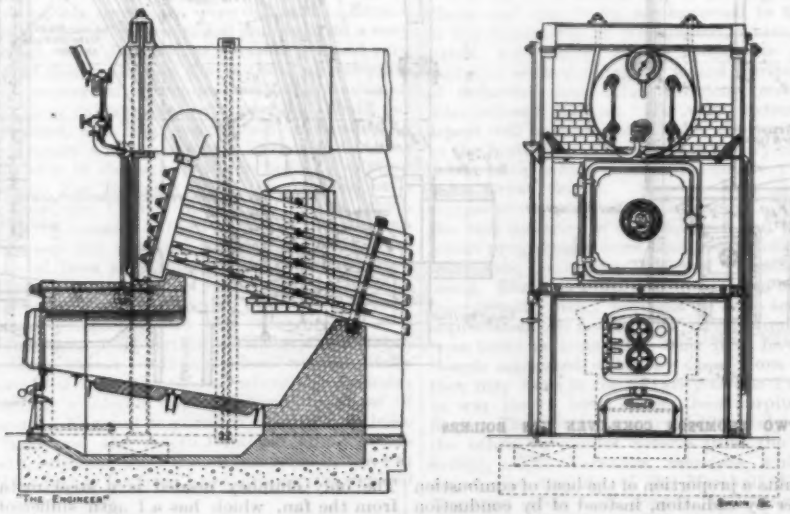


FIG. 71—BABCOCK AND WILCOX BOILER WITH GRATE FOR BURNING SAW-MILL REFUSE

Of the 4876 million units which were generated during the year ending March 31st, 1919, by the electricity supply undertakings in the United Kingdom, 4623 millions were obtained from coal and coke, 68 millions from waste heat, 58 millions from exhaust steam, 28 millions from refuse, 4 millions from tar fuel, 61 millions from gas and suction gas, 23 millions from oil engines and 11 millions from water power. From this it will be seen that waste heat is at present the principal rival to coal and coke, but the possibilities in this direction have not as yet by any means been fully explored. There are, moreover, other alternative fuels to coal besides those dealt with. It is true that some of these fuels may not be very formidable rivals to coal, but in these days they ought not to be neglected. Experiments with colloidal fuel are said to have shown wonderful results, but details are not yet available. Some forty-eight power stations in this country generate a portion of their current by means of dust destructors. It is, however, difficult to procure reliable data relating to the working of these plants, as they are almost invariably run in conjunction with coal-fired or other boiler units. The heating value of refuse in one part of the country may, of course, be very different from that in another. From the public health point of view, refuse destructors are desirable, but their limits of usefulness from the point of view of generating power are well known. Oil fuel and pulverised fuel have been considered in previous articles.

A fair amount has been done during recent years in the way of burning coke. The consumption of coke in electric power stations increased from 26,365 tons per annum in 1918 to 114,991 tons in 1919. Coke breeze or small coke with an admixture of bituminous slack coal can be burnt in varying proportions up to 50 or 60 per cent. on almost any type of furnace or mechanical stoker; but to burn coke efficiently by itself forced draught in some form is essential. Without forced draught the consumption of coke per square foot of grate area is considerably less than that of free-burning bituminous coal, which means, of course, that the evaporating capacity of the boiler will be reduced. For burning coal and coke together on chain grate mechanical stokers, the so-called sandwich system has acquired a certain amount of prominence. Coal and coke are fed from a hopper divided by means of a longitudinal partition into two compartments on to the travelling chain in two layers, the lower layer consisting of coke breeze or small coke and the upper layer of bituminous slack. The initial ignition is therefore provided by the coal. This system has now been adopted with success in a number of power stations, including the London County Council's station. Of late years some attention has been given to the possibility of exploiting the lignite fuels of Bovey Tracey and other West Country districts. Analyses made recently of lignite from Devonshire show somewhat variable results, but in all cases it has a low calorific value and a high percentage of moisture. Forced draught must be used to burn lignite, and either back arch settings or some form of drying hearth similar to that employed in many refuse destructors must be adopted to deal successfully with the high moisture content.

A furnace designed by Babcock and Wilcox for burning saw mill refuse, and which is somewhat similar to that supplied by the firm for burning lignite, is shown in Fig. 70. In the utilisation of saw mill refuse, the considerations guiding the construction of the furnace depend upon the proportion of chips and small pieces of wood to the sawdust and shavings. Where there is a fairly large proportion of small chunks of wood and chips, an extended furnace with a long fire-brick arch has been found to be quite suitable, and a furnace of this type is shown in Fig. 71. Where the proportion of sawdust and shavings is

very large, the fuel should to a great extent be self feeding. Sawdust only burns where air has access to it, and if it is piled up in a heap only the outside surfaces are consumed. The step grate furnace, as shown in Fig. 70, is the most suitable type of furnace for meeting the requirements, because the air readily gains access to the spaces between the bars, and by reason of the fall or incline of the bars, the fuel is self-feeding, and does not accumulate in a large heap at any particular point. The fire-door, it will be noticed, extends across the whole width of the fire-bars, and there is a hopper above the door to provide a continuous supply of fuel. The opening between the dead plate and the fire-door can be regulated at will, according to the draught and the power required from the boilers. Sawdust has been burnt quite successfully on chain grate stokers in accordance with the sandwich system, an inch or two of coal covering 5in. or 6in. of sawdust, and giving the weight necessary to prevent the lighter fuel from being drawn off the grate by the induced draught. Special furnaces are also built by Babcock and Wilcox for various other kinds of fuel, such as spent tan, dried and green bagasse, the refuse from the sugar cane after it has been crushed, town refuse, &c.

Institution of Mechanical Engineers

ALUMINIUM ALLOYS.

THE first meeting of the session of the Institution of Mechanical Engineers, which was held at Storey's-gate on October 21st, was devoted to the discussion of the summary of the eleventh report to the Alloys Research Committee, prepared by Dr. Walter Rosenhain, Mr. Sydney L. Archbutt and Dr. D. Hanson. Captain Riall Sankey, the President, was in the chair.

After the usual formal business had been transacted, the President invited Dr. Rosenhain to present the report.

In doing so, Dr. Rosenhain said that it was the third time that he had had the pleasure of presenting a report on the subject to the Institution, and that nine years had passed since the last occasion. The present report, of which we give part of the official abstract on another page, was, he said, different from its predecessors, in so far that it had been extended to cover a wide group of alloys, instead of being restricted to a comparatively small range. The result was that an enormous mass of data had been collected, but by successive stages of condensation it had been reduced from the 256 pages of the complete report to the form in which it was presented to the meeting. Although it appeared from the title page of the summary that it was the result of the work of the three authors, the research had, as a matter of fact, been carried out by a large organised staff which numbered some thirty people.

A new method of sectionalising the report had been adopted, on account of the strenuous times during which the work had been carried out, and the alloys dealt with had been classified according to the uses to which they were generally put in those times. The investigations had been commenced with the ternary alloys of aluminium, zinc and copper, but it was found that for such services as the pistons of internal combustion engines, where fairly high temperatures had to be contended with, these alloys were practically useless. Attention was then turned to the binary alloys of aluminium and copper, with small additions, and some very remarkable results were obtained. The great improvement which could be effected in the qualities of these alloys by heat treatment was demonstrated with the aid of some lantern slides, which showed that an alloy could be produced that had a greater strength at a temperature of 250 deg. Cent. than at normal room temperatures. Another advantage of these alloys for making pistons, as compared with cast iron, was their high capacity for conducting heat, which made it comparatively easy to keep the pistons cool.

After having investigated the behaviour of these alloys in the form of castings, and obtaining such satisfactory results, attention was turned to the possibility of rolling them into sheets or bars. At first the results were most disappointing, and some slides which were projected on the screen showed how the early attempts at rolling bars must have disheartened the investigators. The metal split up so badly that the bars branched out like a tree or opened out like a book as they emerged from the rolls. The remedy for this state of affairs was found to lie in the use of really sound ingots, and bars were made having a yield stress of about 17 tons per square inch and an ultimate stress ranging up to about 26 tons. Dr. Rosenhain then showed an interesting slide which compared the strength of various alloys weight for weight, and remarked that an alloy might be described as, for instance, of fourteen miles quality. In other words, a bar of that alloy 14 miles long could be hung up by one end without parting under its own weight. The maximum length of steel bar which would hang by one end was scarcely 4 miles.

Dr. Rosenhain then dealt with the fatigue qualities of the alloys, saying that it was more difficult metallurgically to increase the fatigue range by 1 ton than it was to add 10 tons to the tensile strength. At one time, he said, there was some apprehension among engineers as to whether aluminium alloys could be relied upon for any length of time; so he had some castings made, nine years ago, and exposed them on the roof of the laboratory. The castings were periodically measured, and it was found that they had a dimensional stability which was quite good enough for ordinary engineering purposes, although it might not be sufficient for such services as standards of length. Another characteristic discovered by means of these specimens was that some alloys actually increased in strength with age. Some Duralumin test pieces had appreciably hardened during seven years' life, and Dr. Rosenhain wondered if they would continue to get harder still with increased age, or if they would get soft again.

After a few remarks on the resistance of aluminium alloys to corrosion, in which respect the copper, nickel, magnesium alloy was pre-eminent, and a reference to the value of models in carrying out the investigations, Dr. Rosenhain concluded his address by saying that he considered that a great amount of insight into the phenomenon of hardening steel had been obtained in the process of these investigations into the qualities of aluminium alloys.

In inviting Sir John Dewrance, the chairman of the Research Committee, to open the discussion, Captain Riall Sankey commented on the delicacy of treatment required by the alloys under consideration, which was necessary on account of the narrow range of temperature through which they can be safely worked, and raised the question as to whether such delicacy was practicable in commercial manufacturing. He asked for a vote of thanks to the authors, and when it had been acceded in the usual way by acclamation, he suggested to speakers that they should omit expressions of thanks from their opening sentences, and so save the limited time of the meeting.

Sir John Dewrance gave a short history of the Alloys Research Committee, pointing out that its inception dated back some thirty years, a fact which explained how it was that the Institution of Mechanical Engineers, rather than the Institute of Metals, was engaged upon metallurgical work, as it was not until long after the Committee was organised that the Institute of Metals came into existence. It seemed, however, said Sir John, that the immediate functions of the Committee had nearly been completed, and he suggested that the time was coming when such researches might be handed over to the Institute of Metals. Although the Institution of Mechanical Engineers was responsible for the original idea of forming the Committee it had not, of course, borne all the expenses, and the Government, through the National Physical Laboratory, had helped the research enormously. However, even when the work became of direct national importance, on account of the war, he maintained the claims of the Institution, as the originators of the scheme, to priority in the publication of the report. Finally, Sir John suggested that the light alloys might become the raw material with which the large structures of the future would be constructed.

Professor Turner, President of the Institute of Metals, paid a tribute to the foresight of the Institution of Mechanical Engineers in organising the research, saying that in his opinion no work it had done was of greater value to engineering. He pointed out that one of the reasons why iron was a material so universally used was the fact that by the addition of quite small proportions of other elements it could be transmuted into practically an entirely different substance. The researches of the Committee had shown that aluminium could be dealt with in a very similar manner. In one case which had come to his notice, for instance, it was found very difficult to turn some aluminium, and the trouble was traced to the fact that the metal was melted in iron pots. The aluminium absorbed some of the iron, which, the research had demonstrated, remained in the form of insoluble hard particles.

Mr. A. G. C. Gwyer, of the British Aluminium Company, asked the authors' views as to the wisdom of adding iron to aluminium. The addition was not, he said, generally approved in this country, but in America, he believed, from 1 to 2 per cent. of iron was commonly added to aluminium for casting purposes. An important property of alloys, which had not been dealt with that evening, was their coefficient of expansion with change of temperature, as it had great influence on the smooth working of engine pistons and on the making of die castings. In this connection he mentioned that he had received from abroad a die casting of exceptionally good finish, which, on analysis, proved to contain 4 per cent. of silicon and 8 per cent. of zinc. Mr. Gwyer asked if it really was necessary to forge or extrude the ingots of the alloys in the process of breaking down, as it appeared to him that the narrow margin of temperature through which work might be done on the metal would mean that only a very small reduction could be made in each operation.

Engineer-Rear-Admiral R. B. Dixon said that he gathered from the report that the problem of aluminium alloys had been solved as far as their metallurgy was concerned, and that it now devolved on engineers to solve the problem of their use. He was interested in these alloys chiefly in the form of pistons for Diesel engines, and for that purpose had used an alloy containing from 2½ to 3½ per cent. of copper, 1 to 1½ per cent. of nickel, and about one-half of 1 per cent. of magnesium. Some pistons of this metal had been put in service in the post-war Fleet, and although the experience with them had not been very extended, they had worked quite satisfactorily so far. High thermal conductivity was, he thought, a good characteristic in the pistons of internal combustion engines, but in marine work it was not so important as lightness.

Mr. A. E. L. Chorlton said that the mixture just mentioned by Admiral Dixon was one of the first to be used. It was well tested at least as soon as that which was adopted as best for aero-engines. It had not, however, been supplanted by the aero alloy. A great point in its favour was that it permitted the use of pistons as large as 20in. in diameter without water cooling. On the Continent he had found a strong bias in favour of the addition of silicon to aluminium, but he could not give the proportions of the two metals. Mr. Chorlton suggested the possibility of making internal combustion engines as light as ½ lb. per horse-power if aluminium alloys suitable for connecting-rods and crank shafts could be produced.

Mr. S. Payne, of the Royal Airships Works, said that the "Y" alloy referred to in the report had been produced in such a condition that it was suitable for use in general work, but that the "3-20" alloy, although very good natured, was subject to corrosion. One of the striking features of the "Y" alloy was its consistency under test; its tensile strength, for instance, could be predicted within 1 or 2 tons per square inch, which was much closer than was possible with steel. The strength of the alloy could, in fact, be adjusted, within the limits of its capacity, with the greatest nicety to suit the requirements. It was not a difficult material to roll, and the cast ingots could be forged down about 30 per cent. per heat at a temperature ranging between 370 deg. and 400 deg. Cent. The alloy could be rolled down to No. 16 gauge quite easily, but if it was required thinner than that a few more passes through the rolls were needed than was the case with some other alloys. He had, he said, rolled down Duralumin to a thickness of 0.01in. in sheets measuring 18in. by 2ft.

Mr. H. B. Weeks, of the Vickers company, suggested that the authors had not been quite fair in their comparisons between Duralumin and the "Y" alloy. Duralumin was made in four distinct grades, and it was possible that if the makers had been advised as to what tests the specimens would be subjected, they would have been able to offer a metal which would have shown up better. He had had experience with aluminium Diesel engine pistons up to 14in. in diameter, and thought that lightness was more important in small engines than in larger ones. As regarded the authors' statement that Duralumin became harder with age, he had not found that to be the case, excepting, of course, for the primary hardening during the first fourteen days. His experience showed that no difficulty was found in working aluminium alloys on account of the delicacy of treatment which had been referred to by Captain Sankey, but it was most important that the treatment specified should be given. That treatment could be carried out by ordinary workmen in commercial establishments. In some Manchester works, he said, good die castings were made with an alloy containing 4 per cent. of iron.

A group of very interesting samples, which showed, to some extent, the difficulties that were overcome in the course of the research, were exhibited in the lecture hall, and are to be again on view when the discussion is resumed this evening—Friday, October 28th. We commence reprinting the official summary of the Report on page 461 of this issue.

The Future of Stainless Steel.

IT is frequently said that stainless steel was discovered by accident. That is not quite accurate. What did, in fact, occur was that in searching for one quality in steel another was found. Mr. Harry Brearley was some years ago in charge of the Brown-Firth Research Laboratory, and in October, 1912, he made a report to his firm in connection with the erosion of gun barrels, in which he gave various reasons why low-carbon high-chromium steels might usefully be applied to the manufacture of rifle barrels and inner gun tubes. He stated that the mechanical properties of the material were satisfactory, but he anticipated that difficulties might arise in manufacturing operations. After giving some details of results obtained with experimental material, made in the works, and tested in the laboratories, Mr. Brearley said in a concluding paragraph: "We found that this material had also unexpected anti-corrosive properties. Highly polished pieces which have been exposed to the atmosphere in the chemical laboratory for two or three weeks remain perfectly bright, whereas ordinary mild steel becomes quite rusty. If in this respect it can be compared with 25 per cent. nickel steel, it has one great advantage over it, viz., that it can be softened so as to be easily machinable, and, if required, can also be hardened; 25 per cent. nickel steel cannot be hardened, and it is very difficult to machine. The material would appear therefore

to be especially well suited for the manufacture of spindles (hardened), gas and water meters, pistons and plungers for pumps, ventilators and valves for gas engines, blades for turbines, ornamental parts which require to be strong, certain forms of cutlery, &c. &c."

From this authentic statement of the origin of stainless steel, it will be seen, in the first place, that Mr. Brearley believed he had found the material he was in search of—a steel for gun barrels—and that, in the second place, when its peculiar property of resisting corrosion had been observed, he recognised its value, not only for cutlery, but for many engineering uses. It should also be noted that he foresaw the probability that manufacturing difficulties would arise. In that anticipation he was right. A great many things which could only be discovered by research and workshop experience had to be learnt, and for a long time high-chromium steel was reserved for special classes of table cutlery. But step by step as knowledge of its properties and experience in the method of handling have developed, so have its applications extended, and it is now not only a material from which all classes of cutlery—even razors and surgical knives—can be made, but which can be drawn into fine wire or stamped into dishes, saucepans and ornamental embossed articles. Finally, it is becoming an engineers' material, and before many years are past we may expect to find it in regular use in the products of the workshop, and in due course, no doubt, we shall see it employed in ship construction and in the structure of bridges.

Stainless Steel for Engineers.

Unless it be displaced by some other material before it succeeds to this inheritance, stainless steel is destined to become one of the most important metals known to man. It may safely be said that many millions of pounds are spent annually in the endeavour to prevent the destruction of iron and steel by moisture, and that at least as many are expended in replacing structures which preventative coatings have failed to preserve. Could we build ships and bridges of high chromium steel, could we make tanks and roofs of it, could we use it for fences and railings and for the thousand and one appliances of the farm, the garden and the street, which must resist the influences of the weather, the saving of labour and material would amount to a figure which it is impossible to estimate, but which would quite obviously reach enormous dimensions. In the twelve months ending in June last no less than ten thousand seven hundred and thirty-six pounds (£10,736) were spent on labour and material for the painting of the Forth Bridge. Corrosion of iron has, ever since the metal was first smelted on Mount Ida by a forest fire or hammered into spear-heads by Tubal-Cain, remained the one defect that man could not succeed in overcoming, and rust remains to this day the greatest enemy of the works of the engineer. As long as stainless steel was an alloy, suitable for no more important vocation than the paring of fruit, it might be lightly considered. But now that organised research and experiment are enabling us to realise the greater uses which its discoverer foresaw, we must regard it as one of the most valuable inventions that man has made, and one destined to enjoy a future of inestimable importance.

Turbine Blades.

We have summarised recently in these columns—see The Engineer, June 3rd, 1921—the result of a large number of inquiries, conducted in works of various kinds, into the use of stainless steel, and we are now able, through the courtesy of Thos. Firth and Sons, Limited, to give some particulars of its use in steam turbines.

One of the turbines on which these blades were tested is that of a Westinghouse turbo-generator set of 2000-kilowatt capacity running at 3000 revolutions per minute in the power-house of Thos. Firth and Sons at Tinsley, Sheffield. This set was put down in August, 1916, and since that time has been in regular use, the average load being 50 per cent. of the full output, fluctuating from full load to about 25 per cent. of that. The steam pressure is 200 lb. per square inch, and the steam temperature, with superheat, averages about 600 deg. Fah. The experimental stainless steel blades were fitted on June 11th, 1920, and beside them there were fitted, for comparison purposes, a number of new 5 per cent. nickel steel blades of the standard type supplied by the makers. The details of the experimental blades are as follows:—

In wheel No. 8, situated at the low-pressure end of the turbine, were fitted twelve new blades, three of stainless steel highly polished with three of stainless steel unpolished beside them. On the opposite side of the same wheel, three more blades of stainless steel, unpolished, with three standard blades beside them. These blades are 7in. long by 3/4in. wide, the diameter of the wheel being 4ft. 1½in.

In the velocity wheel, situated at the high-pressure end of the turbine, were fitted twenty-four new blades—on one side of the wheel twelve of stainless steel unpolished, and on the opposite side six of stainless steel unpolished with three of stainless steel highly polished and three standard blades alongside. These blades are 7/8in. long by 3/4in. wide, and the wheel is 3ft. 7½in. diameter.

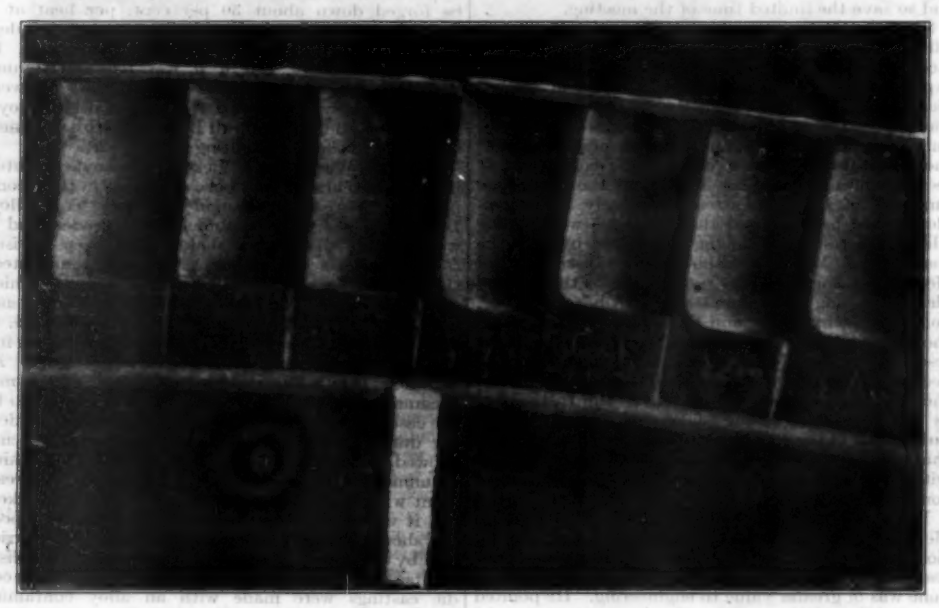


FIG. 1—NICKEL STEEL AND STAINLESS STEEL TURBINE BLADES—FULL SIZE

The blades in the velocity wheel have to meet dry high-temperature steam, and the blades in No. 8 wheel very wet steam.

The work done by this generating set since the fitting of the new blades is represented by a run of 3471 hours, with the demand fluctuating as described above, averaging a 50 per cent. load. On opening up the turbine recently, it was found that whilst the standard blades had corroded in the usual way, the stainless blades, both polished and unpolished, were practically untouched and retained their original brightness. What [discoloration there was was probably due to rust carried over from the other blades, as it could be washed off with a damp rag.

In Fig. 2 we reproduce a photograph showing three unpolished and three polished stainless blades after fifteen months in service. Fig. 3 shows three of the unpolished stainless blades and three ordinary composition nickel steel put in new into the turbine at the same time as the stainless blades. In Fig. 2 the blades have been rubbed with a damp cloth prior to the taking of the photograph; whilst in Fig. 3 they are as opened out. In Fig. 4 we reproduce a photograph showing twelve stainless steel turbine blades as opened out. This engraving clearly shows the difference in the response to both corrosion and erosion when comparison is made with the adjoining nickel steel blades.

The stainless steel contained 0.30 per cent. carbon and 13.4 per cent. chromium, whilst the nickel steel contained 0.19 per cent. carbon and 4.71 per cent. nickel.

The mechanical properties of the two steels as placed in the turbine are given in the following table:

	Nickel.	Stainless.
Yield point, tons per sq. in.	25.2	44.1
Maximum stress, tons per sq. in.	34.7	54.5
Elongation, per cent.	32.0	20.0
Reduction of area, per cent.	61.0	59.7
Brinell hardness number	149	255

A Comprehensive Test.

Early in 1916 the British Thomson-Houston Company, with the consent of one of its clients, had a turbine wheel bladed with five different kinds of material, the object being to find out which of those materials would best stand up against the action of the steam. "The row of blades," wrote Mr. Samuelson to Messrs. Firth, "selected was situated in about the middle of the machine, where we had frequently seen early indications of erosion and corrosion. The blading materials selected were phosphor bronze, nickel bronze, brass, mild steel and stainless steel—two unhardened, and two hardened and tempered stainless blades were inserted. The machine was put into service in the autumn of 1916, and was opened up for examination for the first time in April, 1918. The inside of the machine was found to be perfectly clean, and all blading in a good condition. A certain amount of erosion was visible on all trial blades, except those made of non-rusting steel. The machine had not been in service sufficiently long to see very clearly the preference of one material over another, except that the brass blades seemed to have suffered most. There were no marks whatever on the stainless steel, while the mild steel blade edges were rough; phosphor bronze and nickel bronze seemed to have the same resisting quality to the action of the steam and moisture. A set of photographs were taken. The machine was then closed up and again put into service, and was opened up a second time for examination in July, 1921, and the inspection confirms our previous examination, i.e., that the stainless steel blades were in very good condition and absolutely unaffected, the edges being as sharp as when put in, and there was apparently no difference between the hardened and unhardened samples. The phosphor bronze, nickel bronze and brass blades were all roughened at the entrance edge, and very little difference is to to noted between them. The mild steel blades were badly roughened, and the entrance edge was worn away nearly $^{1}/_{16}$in. A set of photographs was taken again. As far as resisting properties are concerned, the stainless steel is very superior to any other blading material which we have so far tried."

It should be pointed out, says Dr. Hatfield, that in these experiments the blades under test were relatively short, and therefore very lightly stressed, and not subjected to any vibration. At the exhaust end of the turbine the blades are stressed highly, and also are more readily subjected to vibration, and it is to be hoped that the stainless steel will show up equally well under these more trying conditions. This point is, however, satisfactorily answered by the mechanical tests given above.

Pump Rams.

We illustrate also an interesting experiment by Thos. Firth and Sons, Limited, made with a three-throw electrically driven hydraulic pump manufactured by Davy Brothers, Limited, working at a pressure of 1800 lb. per square inch and installed in 1915. One ram was made of stainless steel, the other two being of the standard non-ferrous alloy used by the makers. This pump ran continuously, night and day, until the termination of the war. The wear on the stainless ram is now $^{1}/_{64}$in. on the diameter, whilst in the case of the non-ferrous rams it reaches so high a figure as $^{7}/_{64}$in. Fig. 5 illustrates the present condition of these rods. The less wear upon the stainless rod means much in saving wear of the packing.

We are able to give also reproductions to full size—Figs. 1, 6 and 7—of parts of the blades of the turbines in the Firth power-house. They show in a very striking manner the superiority of the stainless steel blades; but, after all, it is only by a personal examination, which through the courtesy of Messrs. Firth we ourselves were able to make last week, that the full measure of the resistance of high chromium steel, both to erosion and corrosion, can be fully appreciated. It is then seen that the polished metal is barely tarnished, literally almost as bright as the day it was put in, that the marks upon the unpolished blades are mere stains, and that the edges are as sharp as ever. The last-named characteristic is one of great importance. Surface corrosion causes inefficiency by increasing the frictional resistance to the flow of steam through the turbine. Erosion and corrosion of the edges of the blades, by blunting and deforming them, cause inefficiency by setting up eddies and disturbing the stream-line flow of the steam.

Questions which can only be answered by prolonged tests of stainless steel under working conditions are (1) its ability to resist the vibratory stresses which are known seriously to affect turbine blades, and (2) the maintenance of its remarkable chemical and physical properties under the working conditions in turbines. A good deal of light is thrown upon these questions by the prolonged experiment made by the British Thomson-Houston Company and described above, and by the fact, of which we are informed by Messrs. Firth, that one of their customers has had in constant service for between four and five years stainless steel blades, 28in. in length, with entire satisfaction. We cannot, however, help wishing that an opportunity would present itself for drawing some of these high chromium blades and subjecting them after prolonged use to appropriate physical

STAINLESS STEEL TURBINE BLADES

THOMAS FIRTH AND SONS, LIMITED, SHEFFIELD, MAKERS

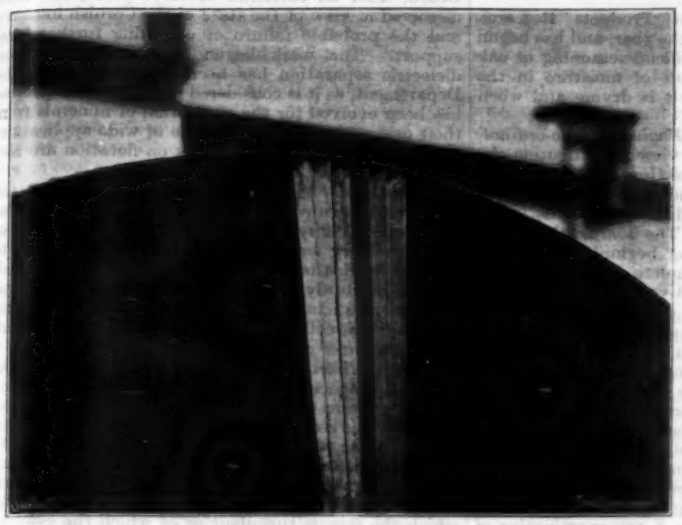


FIG. 2—THREE UNPOLISHED AND THREE POLISHED BLADES AFTER FIFTEEN MONTHS SERVICE

FIG. 3—THREE UNPOLISHED STAINLESS BLADES AND THREE NICKEL STEEL BLADES, BOTH AFTER FIFTEEN MONTHS SERVICE

FIG. 4—STAINLESS STEEL AND NICKEL STEEL BLADES IN IMPULSE WHEEL

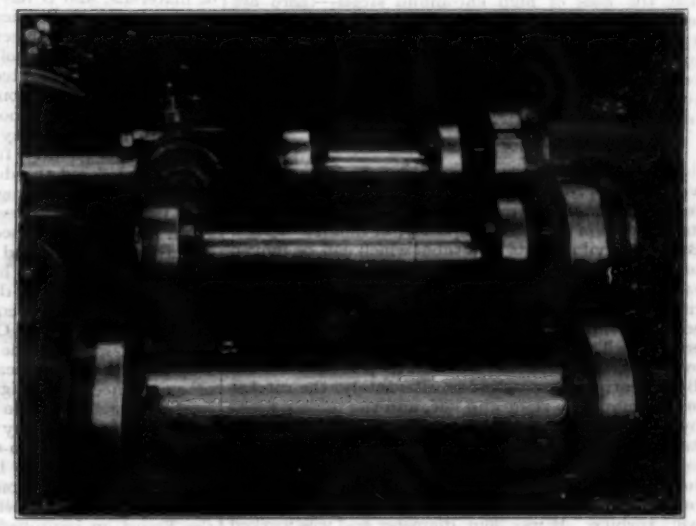
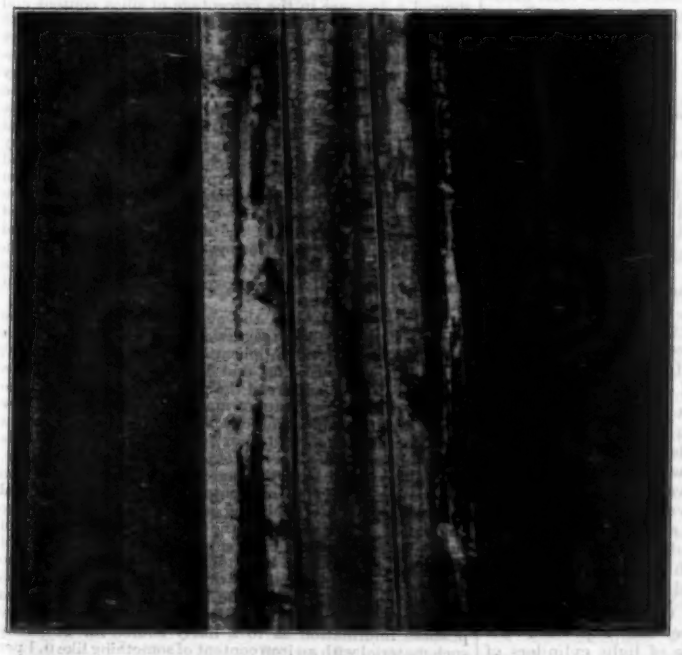
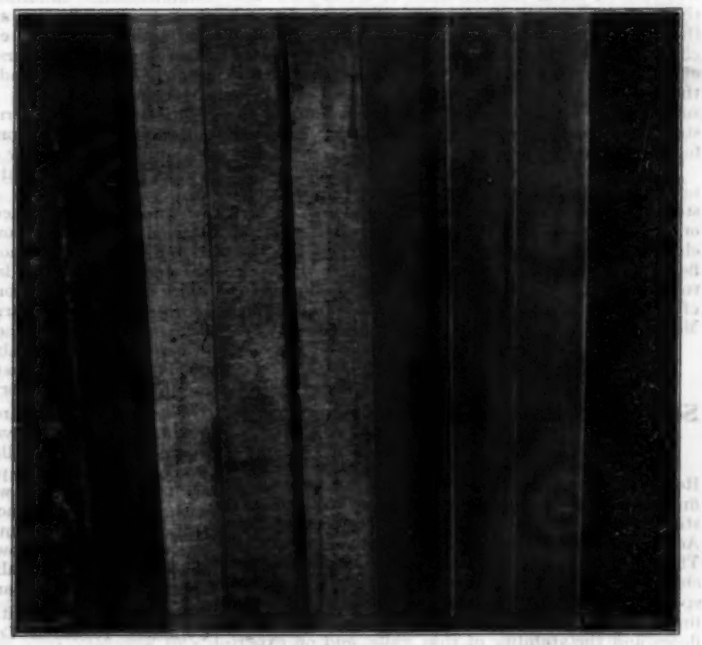


FIG. 4—STAINLESS STEEL AND NON-FERROUS ALLOY PUMP RAMS





FIGS. 6 AND 7—PARTS OF BLADES SHOWN IN FIGS. 2 AND 3 REPRODUCED TO FULL SIZE

tests and to microscopical examination. There is, as far as we are aware, no reason whatever for expecting that they would be other than wholly satisfactory; but since it is not absolutely safe to assume that secular changes do not take place, it would at least be of scientific interest, if in the long run of no practical importance, to know that steels of this kind retain permanently under the trying conditions that obtain in high temperature turbines their remarkable properties.

There is another point of no little moment. High chromium steels are, as we have seen, being tested in competition with nickel steel, bronzes and brass, and, we may add, that in America Monel metal is being used. Assuming that it proves at least as good as any of the non-ferrous metals, how will it compare in price; and, accepting, as we may safely do, that it is greatly superior to other steels, what excess of price over such steels can be tolerated? During our visit to Messrs. Firth's works, we had the pleasure of seeing turbine blade sections rolled, but we imagine that at present the quantity is so small that a price for their production cannot safely be given. We trust, however, that before long a set of wheels may be bladed with this material, and that its commercial position may thereby be settled. We venture to suggest to Sir George Goodwin that he has here an opportunity for displaying that courage in experimentation which has always distinguished the engineering department of the Admiralty.

In the course of our visit to Messrs. Firth's works, which was made in the company of a small party of technologists, we were shown, as already mentioned, the rolling of stainless steel into turbine blade section. We saw it also rolled into cutlery section and into thin plates for stamping, and subsequently, as illustrations to a lecture on the properties of stainless steel which was given by Dr. Hatfield in the Brown-Firth laboratory, we saw many specimens produced from it. They indicated, as we have already said, that the uses of high chromium steels—there are several modifications—are advancing so rapidly that it may already be regarded as an engineering material. In Sheffield 550 tons of stainless steel are made per year for cutlery alone. Who can prophesy what the output for engineering purposes will be in a few years' time?

Forging Turbine Discs.

We were also shown in operation on this occasion a press for producing turbine discs which has been recently completed by Davy Brothers. The press itself is one of 4000 tons capacity, of familiar design. But the anvil consists of a table which can be moved to and fro under the press, and which, moreover, is capable of rotation. Rotation is effected by a ratchet ring provided with a long arm which extends horizontally through the cross head of an hydraulic engine. This engine consists of two hydraulic cylinders, of different diameters, placed *vis-à-vis*. By operating these cylinders alternately, the ratchet arm is moved to right and left, and the table rotated by as much as may be desired. The forging tool has a long rectangular face with a step cut away at one end. In the centre of the table is a depression to form the boss of the turbine disc. The "blank" in the example we saw forged was for a 15,000-kilowatt turbine. It was 36in. diameter and was worked at one heat out to a diameter of 84in. The process was as follows:—The table was moved from under the press, and the blank centred upon it. The table was then returned to position under the tool, which was caused to press upon the blank, making a deep radial indentation. The tool was then raised; the table was rotated about one-sixteenth of a full turn, and the tool was brought down again. So it went on till the circuit had been made several times. Then a circular block was placed in the centre of the blank and pressure applied to drive the metal below into the recess in the table to form the lower boss. Pressure by the radial method was then resumed, the step in the tool, to which we have already referred, forming the upper boss.

Subsequently, a cast was made from one of the nominal 6-ton Heroult electric furnaces in which stainless steel is melted, but the ingot was, in fact, one of tire steel, and an instructive afternoon concluded with a very informative lecture by Dr. Hatfield, which we have unfortunately not the space to reproduce. We may mention that the substance of it was taken from the proofs of a pamphlet which Messrs. Firth will issue a few weeks hence.

Scientific and Industrial Research.

No. III.*

Building Research.—The work of the Building Research Board has been hindered by difficulties in finding suitable accommodation for an experimental station. Ultimately a site was obtained at East Acton, and the necessary buildings were erected. The station is equipped with small engineering and chemical laboratories, workshops, offices and ground space for full size construction. Reports on sand-lime and other concrete bricks, on experiments upon floors and the stability of thin walls, and on experiments upon the transmission of heat and gases through wall materials and the condensation of moisture on their surfaces have been or are to be issued. Among the subjects now being investigated are the preservation of building stones and the economical use of fuel in brick-burning, with special reference to the gas firing of kilns.

Forest Products.—A Forest Products Research Board was established during the year, and has begun work by investigating the artificial seasoning of oak and spruce and the movement of moisture in the interior of timber both when it is drying and when it is absorbing moisture.

The Physics, Chemistry and Engineering Co-ordinating Research Boards.—With a view to instituting the closest possible co-ordination of Government research work, particularly of that conducted by the fighting services, three main co-ordinating boards were appointed about a year ago. The boards, the report states, have made a promising beginning, but time will be required before a complete organisation can be built up and become effective. In the course of the work done by the boards during the year under review very few instances of overlapping, it is reported, were found. From the detailed reports regarding the work of the Committees separately, we learn that the Physics Board is carrying on researches in sound location by arrangement with the Admiralty and War Office, and has become responsible for the continuation of the Admiralty's work on leader gear in view of its importance to the mercantile marine and the discontinuance of the naval authorities' experiments on the subject. The same Board has also interested itself in the X-ray examination of materials, the production in this country of high-class insulating materials, and other matters which were being studied by more than one other Government department or other body. The Engineering Co-ordinating Board has arranged with the Aeronautical Research Committee for the conduct of fundamental researches at selected universities into the fatigue of materials, and is having carried out on its behalf at the National Physical Laboratory investigations on a variety of subjects, including motor springs, bearing metals, soft solders, and the effect of heat treatment on nickel steel. The Chemistry Board is having experiments conducted at the Royal Naval Cordite Factory, at Woolwich and at Oxford University into the possibility of manufacturing formaldehyde in this country from non-imported materials. It has considered the desirability of further Government research on nitrogen fixation, but has decided that no action is necessary at present. It has also given its attention to securing a supply of helium for scientific research and for research into possible commercial uses, but has so far been unsuccessful. Luminous paint, the development of accumulators and dry cells and the acquisition of a supply of radium have also engaged the Committee's attention.

Radio Research.—The work of the Radio Research Board has been handicapped, it is stated, by a lack of experienced investigators with sufficiently high qualifications to enable them to undertake the type of research required by the Board. For this reason the work of the Sub-committee dealing with the propagation of waves has been mainly confined to theoretical considerations. At the National Physical Laboratory work is being carried out on behalf of the Board on improved methods of measuring high frequency currents and resistance, and on the accurate measurement of wave lengths. At the Aldershot Wireless Station very promising preliminary results have been obtained in an investigation into the origin and nature of "atmospherics." With the co-operation of seven universities and four Government establishments, simultaneous observations with identical direction-finding apparatus are being made on the transmissions of certain fixed stations. The observations and errors noted are stated to be extremely interesting, and will be published in a report to be issued this year.

Adhesives.—The term of appointment of the Adhesives Research Committee expired on December 31st, 1920, but in view of the importance of its work it was decided to continue it in existence. Under Dr. Schryver, at the Imperial College of Science, attention is being concentrated chiefly on adhesives derived from animal sources. It is hoped ultimately to found a sound technology of glue manufacture, and to elucidate the fundamental nature of adhesion. Work on the production of adhesives from vegetable sources is also being carried out, and already a process has been evolved for the production from the residues of castor beans and other oil seeds of an adhesive of good general quality suitable for use in the manufacture of plastic materials and distempers.

Oxygen Research.—Important advances have been made in the means of evacuating vessels for containing liquid air. At the Kidbrooke depôt of the Royal Air Force an evacuating plant has been designed and erected which can deal with six vessels simultaneously, with increased efficiency of evacuation and with a reduction in cost from £3 to about 7s. per vessel. The Committee has now in hand the preparation of a work of reference dealing with the production and application of oxygen and liquid air.

Gas Cylinders.—With one dissentient the Gas Cylinders Research Committee has expressed the view that the use in commerce of light cylinders of high carbon steel may be safely recommended. The representative on the Committee of the Railway Companies disagreed with this view, and holds that cylinders of low carbon steel, in accordance with the Home Office Specification of 1895, with slight modifications, should be adhered to.

Tin and Tungsten.—The Tin and Tungsten Research Board, after an existence of three years, has been dissolved in view of the state of the Cornish industry and the probable failure of obtaining further local support. The work begun under this board on dielectric separation has been continued under the Department, as it is considered possible that a process has been evolved for the separation of minerals from their ores which may be capable of wide application. Some laboratory investigations on flotation are also being continued.

Lubrication.—The report makes reference to the now well-known results of Mr. Hyde's experiments at the National Physical Laboratory on the effect of adding a very small quantity of free fatty acid to mineral lubricating oils. At Cambridge, it is added, Mr. W. B. Hardy is carrying out a general investigation into the relationship between chemical constitution and lubricating properties, and on the influence of the nature of the solid surface.

Gauging Rivers and Tidal Currents.—In order to forestall the needs of any survey of the water and water-power resources of the United Kingdom or of the Empire, a committee has been appointed to collect and examine the information available as to the means of measuring the flow of rivers and tidal currents. It appears probable that further experimental work will be required on the gauging of streams in which the flow is turbulent or of which the velocity is low.

Assisted Researches.—The concluding portion of the report deals with the research work being undertaken by independent institutions and private workers with the assistance of grants from the Department. The following is a list of the subjects being studied by institutions or other bodies:—Continued from previous year: Glass technology, hard porcelain, technical optics, corrosion of condenser tubes, de-gumming of silk, deterioration of structures in sea water, domestic heating and ventilation, dye problems, electrical research, flow of steam through nozzles, industrial fatigue, tool steel, and palæo-botany. Begun during 1920–21: Tides, corrosion of aluminium and power alcohol. The distribution of grants to private workers studying various branches of science was effected during the year in accordance with the following table:—

Subject	To students.	To research workers.	For equipment.
Chemistry	95	20	8
Physics	6	19	11
Mathematics and astronomy	1	6	4
Biology	18	13	8
Geology and mineralogy	3	3	2
Metallurgy	1	4	1
Engineering	7	5	9
Aeronautics	1	—	—

SOCIETY OF GLASS TECHNOLOGY.

The opening meeting of the session 1921–22 was held in the Applied Science Department, the University, Sheffield, on Wednesday, October 19th, 1921, the president, Dr. M. W. Travers, F.R.S., in the chair. Prior to the meeting members had an opportunity of lunching together, when the president made some observations on the work of the new session.

The first paper given at the meeting was by Mr. G. V. Evers on "The Comparative Compositions of Pot Clays from the Stourbridge District during the Last Fifty Years." It was found that the clay of the present day showed a decrease in the percentage of silica content and a corresponding increase in the alumina content. Its refractoriness was in no way inferior to that of clays obtainable thirty and fifty years ago. Therefore the complaint of glass manufacturers and other users of refractory materials that the refractories of to-day are inferior to those of yesterday would hardly be substantiated. In the lecturer's opinion the greatest failure in pots of the present time was due, not to the inferior quality of the refractory materials, but rather to the higher temperatures used and the increased production, involving increased duty on the pot. If the refractory manufacturer was to make improvement in the quality of his material he needed the active co-operation of the users of his material, and the author made a plea for systematic information from the users of refractory materials, which would enable the producers to modify or improve their refractories to suit particular requirements.

The second paper on the agenda was entitled "The Properties of the Lime-magnesia (Dolomite Lime) Glasses and their Commercial Application," by Violet Dimbleby, S. English, F. W. Hodkin, and Professor W. E. S. Turner. Professor Turner, who read the paper, said that the introduction of small amounts of magnesia together with lime resulted in the production of a more fluid glass which was much more easily melted than the corresponding magnesia or lime glasses. The lowering of the annealing temperature, due to the use of both the ingredients, and the reduction as compared with the lime containing glass of the thermal expansion, rendered annealing easier and would reduce the amount of fuel required for the lehrs. The production of such glasses depended on a supply of a suitable form of magnesia or dolomitic limestone. Up to the present no source of such material in which the iron content was sufficiently low to permit the manufacture of colourless glass from it was known, and an appeal was made for any possible information as to a likely source for obtaining such material with an iron content of something like 0.1 per cent.

* No. II. appeared October 21st.

A Seven-Day Journal.

Railway Rates and Industry.

An important concession has been made by the railways as the outcome of an inquiry before the Rates Advisory Committee on Tuesday last and at a previous sitting in connection with the transport rates on coal and other raw materials used by the iron and steel trades. The case for exceptional treatment is a strong one owing to the high percentage that railway charges bear to the cost of making and marketing pig iron. It was pointed out that to meet foreign competition pig iron must be sold at between £4 and £5 per ton, and even in some of the most favourably situated districts for short hauls of raw material and fuel, railway charges on inward traffic work out at about 28s. per ton. In districts like South Staffordshire, where the distance from which the raw material has to be transported to the blast-furnaces is considerable, railway charges amount to 40s. per ton. From these figures it is evident that the question of railway charges has a vital interest to the pig iron industry, and that there is an outstanding case for exceptional treatment. Certainly in no other industry are producers so seriously affected by transport charges. It should further be pointed out that the question of the retention of the blast-furnace trade is of supreme importance to the whole of the commercial and industrial interests of the country, and that if British railways are deprived for any considerable period of the blast-furnace traffic, which it is acknowledged is the cheapest traffic to handle, it is inevitable that the charges on other classes of traffic cannot be so soon reduced as otherwise they might be.

Nile Irrigation Plans.

A rumour is prevalent, but has not been confirmed, that Abyssinian envoys have arrived in Egypt to make arrangements by which lake Tansa will be made available for irrigation works. It is known that the British Government has for some years past been desirous of obtaining from the Abyssinian Government authority to construct irrigation works at lake Tansa, the source of the Blue Nile, with the object of perfecting the irrigation of the lower Nile. On more than one occasion in past years this project has been the subject of discussion between representatives of the two Governments, but it has not been found possible to reach an agreement on the various points involved.

Indian Iron and Steel Works.

The formation by the Cammell Laird interests, in conjunction with Bird's, of Calcutta, of a strong iron and steel company marks the beginnings of an undertaking which aims at a yearly output from works in India of from 600,000 to 700,000 tons of pig iron and of 450,000 tons of finished steel, and as a first step it is proposed to erect a unit capable of half this production. The site of the works will be where iron ore of good quality and excellent coking coal occur close together in large quantities in Bihar and Orissa, and it is predicted that the works should be able to produce steel at a lower price than any other works in the world. The iron ore, it is stated, lies in the heart of deposits which have recently been stated on the authority of a geological survey of India to be hematites usually appearing to contain about 64 per cent. of iron, while samples from the better parts contain about as much as 68 or 69 per cent. iron. The phosphorus ranges from .03 to .08 per cent., or in some cases to as high as .15 per cent., and the sulphur content is usually below .03 per cent. Enough is known, it is said, to justify the belief that the quantities available will run into hundreds, possibly thousands, of millions of tons. The Corporation is taking options on the raw materials areas, and the works will therefore be assured of ample supplies of excellent quality at the lowest possible cost. The board of directors will be domiciled in India, but a strong advisory committee has been formed in London, and includes such well-known names in British industry as Mr. W. L. Hichens, Mr. Max Muspratt, and Lord Inchcape.

Electric Railway Extensions.

The London Underground railways are desirous of carrying out the improvements and extensions which they have had under contemplation for some years past, and have put forward an application involving the raising of £6,000,000 of capital. Detailed plans have been prepared for the reconstruction of the City and South London Railway, the connecting of that railway with the Highgate and Hampstead Tube between Euston and Camden Town, the linking up of the Central London Railway with Richmond, and the extension of the Hampstead Railway from Golders Green to Edgware. It is estimated that the works would provide employment for 20,000 men for a long period. The aid of the Government is being sought for the reason that the railway company is not in a financial position to provide the necessary capital without a Government guarantee in respect of interest, which, it is believed, would be justified by the urgent need of carrying out the scheme outlined, altogether apart from the fact that it would provide employment for a very large number of men, not only in connection with the main operations themselves, but in subsidiary industries as well.

New Road Schemes.

Favourable consideration was given by the London County Council at its meeting on Tuesday to proposals for road construction put forward by Sir Henry Maybury on behalf of the Ministry of Transport. The scheme, which is put forward at this juncture partly with the object of providing employment for some thousands of men, includes the extension of a road connecting Erith and Dartford, the enlargement of the London-Folkestone road, the widening of the Dover-Farningham road, the improvement of the London-Dover road, of the old Roman road known as Watling-street, and a continuation of the Eastern avenue across country from Romford to Southend. The fact that so many of these road schemes are in the county of Kent is a reminder of Sir Henry Maybury's former official association with engineering work in this home county. The cost of the works outlined is estimated at £2,025,000, of which it is considered half would be paid in wages, and it is proposed that the London County Council should contribute one quarter of the cost. If the works are approved, they would be carried out by the Ministry of Transport, and preference given in engaging men to the London unemployed. It is thought that in the exceptional circumstances now prevailing, although local authorities have their own unemployment problems to solve, there would be no objection to the policy proposed. This is not, of course, the only scheme which has been put forward during the past week to alleviate unemployment. The Ministry of Agriculture and Fisheries proposes to carry out some important land drainage works, and the London County Council intends to proceed without delay with sewer construction in the Hammersmith, Charlton and Wandle Valley areas. These works will involve an outlay of nearly two millions, a large percentage of which would be paid as wages.

New Italian Airship.

It has been decided by the Italian authorities to build a new semi-rigid airship, which, in its general features, will show an improvement on the Roma, which, it will be recalled, was recently sold to the United States. It is reported that the new ship, which has been named the Napoli, will be the largest semi-rigid airship in the world. It will have a capacity of 58,000 cubic metres, and will be equipped with twelve Spa 200 horse-power engines disposed tandem fashion. With only four of these engines in operation it is estimated that a speed of 45 miles per hour can be attained. The design makes provision for repairs to engines and for the changing of the propellers to be carried out while the ship is in the air. Accommodation is to be provided for 100 passengers.

New Capital Ship Contracts.

Persistent rumours which found currency at the beginning of the week suggested that contracts had been placed for three of the new battle-cruisers with Clyde yards—John Brown's, Fairfield's and Beardmore's being named in this connection—and one with Swan, Hunter and Wigham Richardson's. Some surprise, as well as disappointment, was caused by the circulation of these rumours, but the explanation was freely given that the Clyde firms named had put in lower prices than other firms which had been asked to tender for the new capital ships. It now appears from an official statement that contracts for only three ships have been let; one for hull and machinery to John Brown's, a similar contract to the Fairfield Company, and one for a hull to Swan Hunter. It is understood that the order for the fourth vessel remains over for further consideration. Several firms have been awarded contracts for armament and machinery, including Cammell Laird's, Vickers', Armstrong Whitworth and the Parsons Company. It is also stated that a sub-contract for boilers has been let to the Palmer Company.

Release of Zinc Concentrates.

An announcement which has been expected for some weeks past has now been made by the Board of Trade. It relates to instructions which have been given to its agents in Australia to ship a supply of Broken Hill zinc concentrates to Great Britain, and, if required, to maintain supplies to meet the requirements of home smelters. The interest of this announcement lies in the fact that British spelter works have been closed down for a considerable period, partly at least for the reason that it has not been possible to obtain supplies of the raw material which, as this week's announcement indicates, has been under the control of the Board of Trade. It is hoped, as a result of the action now taken, that the large works in the Swansea district will be able to resume operations almost immediately, although it must be admitted that the market prices of spelter remain too low to give any real prospect of profitable working. The British Metal Corporation of London has been appointed agent of the Board of Trade in this matter, and will deal with applications both for immediate requirements and future deliveries.

Aero-engine Design.

Reference has been made in previous comments on this page to the greater encouragement offered to aviation in France as compared with this country. The latest evidence of this is the offer of a prize of 1,000,000f. by the Committee for Aeronautical Propaganda for an improvement in the aero-engine. It is good news that the competition will not be confined to French aeronautical engineers, but will be open to engineers of all countries, the only condition being that if the prize should be won by a foreign designer he must manufacture the engine in France. The reason for promoting the competition at the present time is that there is an insistent demand for a more powerful engine unit designed for low fuel consumption. Ample time is allowed for experimental work, as the tests will not begin until June next.

The Deutschland Explosion.

A verdict of "Accidental death" was recorded as the result of the inquest on the five victims of the explosion on the ex-German submarine Deutschland at Birkenhead last month. The cause of the explosion was assigned to the ignition of a mixture of oxygen and hydrogen gases which were released from a cylinder on the submarine. Comment was made by the jury and the Coroner on the want of care by Admiralty officials in examining the cylinders before delivering the vessel to the shipbreakers. The Coroner referred to the fact that apparently no submarine had ever been known to carry hydrogen, but expressed surprise that Admiralty officials should have been content to accept the assurance of the German officers who surrendered the submarine that there were no explosives, infernal machines or booby traps on board. The presence of hydrogen is in some quarters held to be accounted for by the fact that the Deutschland was built to make voyages to America.

No University for Reading.

The attempt to obtain for the University College, Reading, a charter conferring University rank has failed. The College, which dates from the year 1892, has an endowment fund of £250,000, which was raised with the object of making the College an independent University with faculties of letters, science and agriculture, and there was not only no opposition to the petition, but strong support for it in Reading and neighbouring districts. The attitude of the Privy Council is that while the quality and merit of Reading College is approved, a charter should be withheld until a larger number of students intending to take the University degree have been obtained, and the annual income raised to £80,000. When these conditions have been met the Privy Council will give the question of a charter further consideration. The Council of the College will endeavour to comply with the requirements outlined in the letter communicating the decision of the Privy Council.

Sale of Obsolete Warships.

The present high rate of unemployment has led the Admiralty to give consideration to the disposal in the immediate future of more surplus warships. These are offered for disposal at moderate prices to breaking-up firms which can give an undertaking to begin work upon the ship as soon as the sale has been completed. In the case of purchasers of good commercial standing arrangements will be made for payment of the purchase price by instalment. Preference will be given to buyers who will undertake to employ on the work of ship-breaking a substantial proportion of men of the Royal Fleet Reserve. Those who desire to obtain detailed information on the subject should apply to the Director of Navy Contracts.

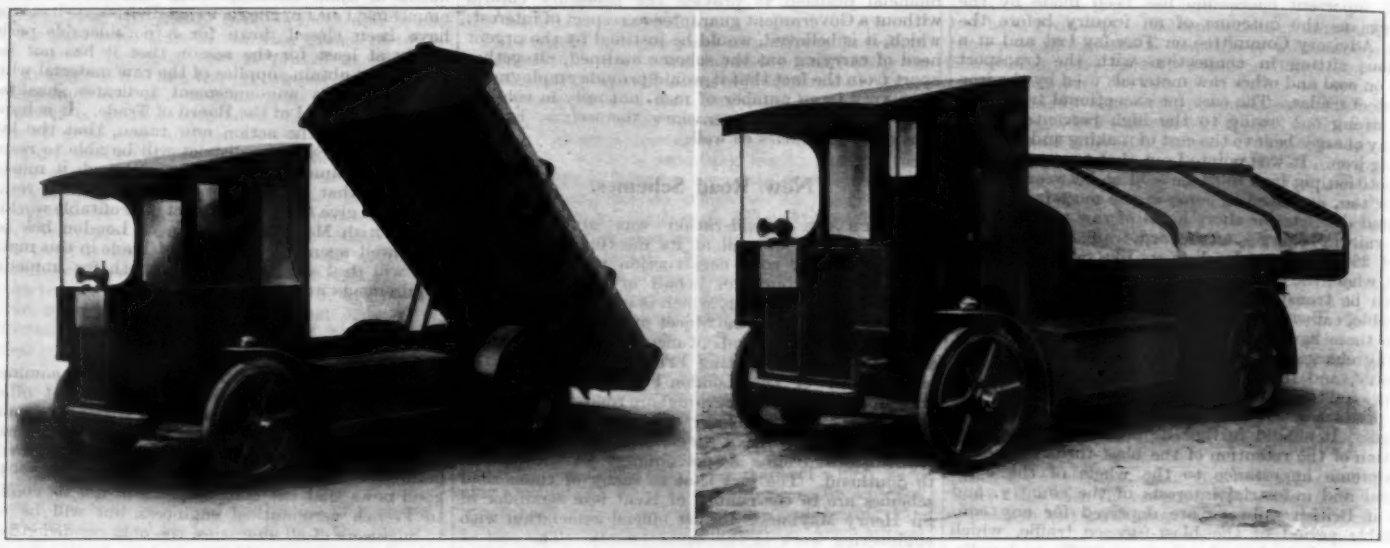
The Commercial Motor Exhibition.

No II.*

A FACT which the Exhibition brought to light was that two firms which have hitherto been engaged solely upon the construction of mechanically propelled vehicles have of late embarked upon the manufacture of electric vehicles. The firms are Guy Motors, Limited, and Clayton Wagons, Limited, but unfortunately we are not at the moment in a position to illustrate and describe the new vehicles. These two additions to the concerns engaged in this kind of business indicate that the possibilities of electric battery traction are becoming more generally recognised, and in all probability the time is not far distant when most of the existing builders of mechanically propelled vans and lorries will have an electrical department.

Newton Brothers (Derby), Limited, were exhibiting an electric lorry with a tipping body, as shown in 14 and 15. The vehicle is well suited for the collection of refuse, and the body is designed for a load of 2½ tons. An electric motor operates the tipping gear, and owing to the provision of an automatic switch, cannot overtip the body. Two slow-speed motors drive the rear road wheels independently by means of a toothed pinion and an internally toothed steel ring attached to each road wheel. To obviate road shocks the motors are suspended on springs, and all vibration arising from rough roads, &c., must pass through two spring systems in series. This type of suspension is also said to prevent undue shocks being transmitted to the driving mechanism whilst the vehicle is starting and stopping. All parts of the motors can easily be inspected. Obviously with the form of transmission described all differential gears, chains, bevel gears, cardan shafts and countershafts are eliminated, and the mechanical design is so simple that if it should be necessary to dismantle the vehicle entirely and re-assemble it again, no operation, the makers state, is more difficult than that of merely removing and replacing a road wheel. The body is composed entirely of steel, and is only 4ft. 6in. above the road level, and in most cases only 3ft. and a few odd inches above the pavement. The cab has a front entrance and several of these vehicles can consequently be garaged with their hubs together, so as to save space. The control gear is arranged so that parts can readily be renewed. It is also foolproof, and if it is necessary to stop the vehicle suddenly in the case of emergency, the current can be cut off and the brakes applied simultaneously by one movement. The removal of a cover plate on the front of the cab enables all the circuits to be tested without disconnecting any wires. A thief-proof switch is fitted.

Several petrol-electric vehicles were exhibited by Tilling-Stevens Motors, Limited, of Maidstone. Vehicles equipped with this form of transmission are made by the company for various kinds of service, and on account of the absence of a direct mechanical connection between the engine and back axle and the absence of a gear-box and clutch, exceptionally smooth running is secured. The 4-ton petrol-electric chassis shown in Fig. 16 was one of the firm's exhibits. A four-cylinder engine is coupled to a dynamo which is connected by means of cables to an electric motor coupled to the rear road wheels through a cardan shaft and differential. Chassis of this type weigh 3 tons 15 cwt., and when used for lorry work they will carry a load of 4 tons, or if used for passenger service, the body of the vehicle can be designed for from thirty to fifty-seven seats. The principal dimensions are as follow :—Wheel-base, 14ft. 6in. ; track, 5ft. 8in. ; overall length, 24ft. 6in. ; body space, 13ft. The petrol electric system has now been applied by Tilling-Stevens, Limited, to the char-à-banc, and Fig. 17 shows a vehicle of this type which was at the exhibition. In the design of this char-à-banc every endeavour has been made to provide comfort. Accommodation is provided for twenty passengers, who occupy separate and slightly staggered seats. A large boot is built in the back of the body to accommodate passengers' luggage. The 2-ton chassis is one of the builders' latest types, and is equipped with a 25–30 horse-power four-cylinder engine, the bore of the cylinders being 105 mm. and the stroke 120 mm. The principal dimensions of the chassis are :—Wheel-base, 12ft. ; track, 4ft. 9in. ; overall length, 18ft. 10in. ; loading space, 10ft. 6in. ; and weight, 2 tons 11 cwt. The body was designed and built by Thomas Tilling, Limited. The petrol-electric double-deck omnibus was another of the firm's exhibits. This is one of the latest petrol-electric omnibuses as run by Thomas Tilling, Limited, in London. The body is mounted on a standard petrol-electric chassis, which is equipped with a four-



FIGS. 14 AND 15—NEWTON'S ELECTRIC LORRY WITH TIPPING BODY

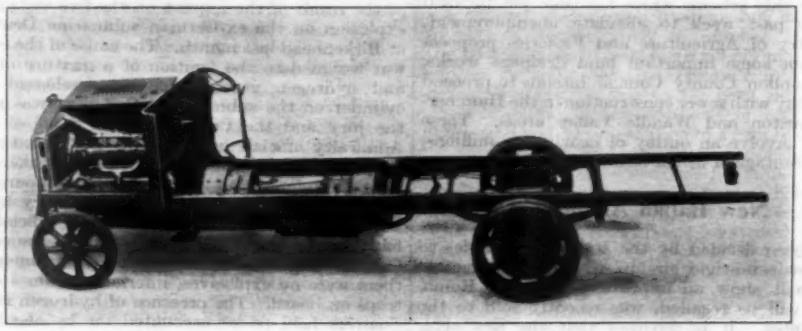
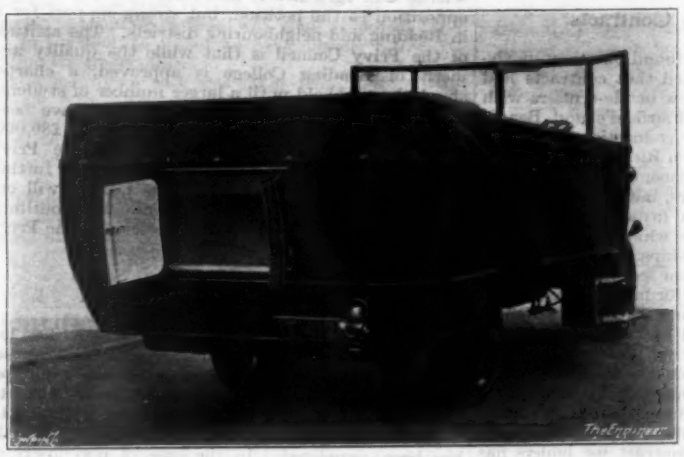


FIG. 16—TILLING-STEVENS PETROL-ELECTRIC CHASSIS



FIGS. 17 AND 18—TILLING-STEVENS PETROL-ELECTRIC CHAR-A-BANC AND OMNIBUS

* No. I. appeared October 21st.

cylinder engine, with 3½in. bore and 5½ in. stroke. The vehicle is capable of accommodating forty-eight passengers, there being twenty-two seats on the lower deck and twenty-six on the upper. On the latest vehicles of this type the staircase is made extra wide so as to increase the speed at which passengers can enter and leave the vehicle. Special attention has been paid to the interior ventilation.

An accumulator which appears to be giving very good results in connection with the operation of battery road vehicles was exhibited on the stand of Richard Garrett, Limited. This accumulator, which is shown in Fig. 19, and which is manufactured at Fuller's United Electric Works, Limited, of Chadwell

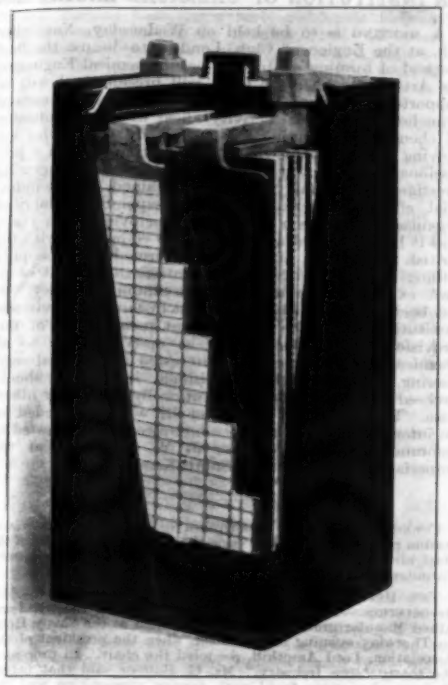


FIG. 19—FULLER TRACTION CELL

Heath, Essex, has fairly thin plates, which are spaced apart by thin separators. In the design of these cells a sludge space of 3½in. has been adopted as standard, as this gives plenty of space at the bottom of the container to prevent the plates being short-circuited by the accumulation of sludge. Since it has been found that splashing usually occurs in the centre of the cell, the lugs are brought through the lid as near as possible to the edge of the box. Cells of this type, which are made with capacities ranging from 87 to 400 ampère-hours, have, it seems, been employed for working electric vehicles with marked success, and we understand they are guaranteed for a period of two years.

On the gallery there were, as usual, many small exhibits of a distinctly useful character, such as lighting and ignition sets. The standard omnibus lighting sets as used by the London General Omnibus Company were shown on the stand of C. A. Vandervell and Co. There were also specimens of the "C.A.V." Willard storage cells with threaded rubber insulation between the plates. In order to avoid the transmission of shocks and vibration to the plates of accumulators, the company has introduced a spring suspension system for the container, and it is claimed that on commercial vehicles fitted with solid tires the arrangement will undoubtedly eliminate many of the battery troubles that have hitherto been experienced. In addition to sparking plugs, &c., the firm was also showing illuminated signs for use on commercial vehicles.

Several exhibitors were showing new coil ignition sets. One of the most ingenious of these sets was exhibited by the Automotive Products Company, of 3, Berners-street, W. 1, and Fig. 20 shows the coil and distributor. Another view of the apparatus, showing, in addition to the coil and switch, various details, such as the condenser and contact breaker, is given in Fig. 21. The set is designed to give two distinct kinds of sparks in each cylinder, a single spark for normal running, or a series of high-frequency sparks, and by simply turning a switch the coil can be made to produce either kind of spark at will. When the small switch knob shown in the illustrations is turned to the starting position the coil gives a rapid succession of powerful sparks, which occur at the points of the plug at the rate of over 60,000 per minute, and these sparks are, of course, supplied to the various cylinders by means of the distributor. The high-frequency system is useful in the case of emergency. On a cold day, for example, when, as everyone knows, engine starting is often difficult, the high-frequency spark system will, it is said, greatly facilitate starting. Heavily fouled plugs cannot, it is said, interfere with the working of the engine when the high-frequency system is brought into use, as the points of the plugs are swept clean of all oil and other accumulations by the rush of the sparks from one point of the plugs to the other. Single or multiple sparks can be obtained at any moment simply by turning the small switch knob, which is marked "Start" and "Run." The use of this duplex ignition system is claimed to enable the engine to run at low speeds and also to give the maximum acceleration. Other advantages claimed for the system are that it reduces gear changing, the lag of the spark is eliminated without the use of a governor, weak mixtures are easily ignited, the consumption of petrol is reduced, hills can be mounted without labouring the engine, and as the current consumption of the set is low, sparks can be obtained even when the batteries are practically exhausted. In order to ensure, however, that the set will work under all conditions, a dry battery is carried in addition to the lighting accumulator, and either battery can be brought into use by means of the battery switch to be seen in Fig. 21. In the design of this ignition set a great deal of ingenuity has been exercised, but we cannot at present spare the space to go very deeply into details. The high-frequency sparks are, of course, produced by a vibrator, and one of the important features of the apparatus is the provision of means which enable the direction of the current through the vibrator to be reversed so as to prevent the deformation of the contact points. Another notable feature is the provision of means whereby the primary circuit may be closed through either the vibrator or the contact maker and interrupter, whilst at the same time avoiding the closure of the primary circuit through both. Very careful attention has been paid to the design of the condenser. Layers of conducting material and dielectric material are wound together in the form of a cylinder and placed inside a casing which can be compressed. The condenser is subjected to a pressure in opposite directions, whilst it is restrained from expanding in a direction at right angles to the direction of the pressure, with the result that the complete condenser is made to assume a rectangular form. The condenser is then immersed in a dielectric impregnating liquid such as wax or olive oil, which is heated to maintain it in a fluid state, and an electric current is passed through the condenser. Any moisture contained in the condenser is therefore driven out in the form of steam, and the moisture is replaced by the liquid dielectric. The contact-breaker for opening and closing the circuit when the coil is working on the single spark system is also constructed on special lines, and ensures that the circuit is only closed momentarily and works with certainty at all speeds. A spring-pressed contact forms one terminal of the circuit, and a spring-retracted contact the other terminal. Both contacts move along a common straight line, and the breaker is actuated by a rotating cam. When the engine is running in the correct direction the device gives an instantaneous break, but ceases to make and break the circuit when the cam shaft moves in the reverse direction.

Another firm which was showing an excellent collection of ignition devices was the British Thomson-Houston Company, of 77, Upper Thames-street. In addition to impulse starters and magnetos of various types, some of the firm's "Tungar" rectifiers for charging accumulators from alternating-current circuits were shown. Of the various kinds of rectifiers that have been introduced the Tungar rectifier is probably the most simple. Its main parts are a bulb which rectifies the current, a transformer and a reactance. The bulb operates in the same way as the thermionic valve used in wireless telegraphy, and allows the current to flow in only one direction, and the cells cannot discharge back through the rectifier. The transformer and reactance are used for adjusting the current and voltage according to requirements. The ease with which these rectifiers can be put into operation is a marked advantage, and there is little doubt that when they are better known they will be widely used in motor garages and other places.

A special wagon which has been devised for delivering, and weighing on delivery, coal in 1-ton lots was exhibited by W. and G. Du Cros, Limited, of 177, The Vale, Acton, London, W. 3, and is illustrated by Fig. 22. The vehicle is intended primarily for such services as the delivery of coal in pit villages, and is, therefore, arranged with a specially short wheel base, so that it can manœuvre in cramped quarters. It will convey two consignments of 1 ton each. The chassis is of the maker's standard type for carrying 2 tons, with the exception that the wheel base has been shortened to 9ft., and is equipped with a 22.4 horse-power (R.A.C. rating) engine having four cylinders 3½in. by 5½in. The engine is capable of developing 25 horse-power when running at 1000 revolutions per minute, and drives on to the back axle, through a worm gear, with a ratio of 6½ to 1. The body, as will be seen from the illustration, takes the form of two steel hoppers, each of which will hold a ton of coal. These hoppers have doors at either end and can be tipped transversely on either side about pivots arranged on an upward extension of the main framing. A hydraulic ram is used to effect the tipping and is supported on a little carriage which can be moved along the frame from one hopper to the other. This ram is also used for weighing the load, by means of a pressure gauge, and consequently cannot be kept tight by means of a cup leather, as the friction would quite prevent accurate weighing. Piston rings are therefore used to check the leakage of the oil used in the ram, and any oil which may escape drains straight back to the pump chamber. The ram itself is hollow and works outside a fixed plunger, while it is in turn surrounded by the body of the casting. In this way both the inner and outer surfaces of the ram are taken advantage of for guiding purposes, and the makers tell us that even if all the load in a hopper is crowded up to one end it will not put sufficient racking stress on the ram to make it bind. A simple hand pump is used in conjunction with the ram. The process of weighing is quite simple, as it is only necessary to take the weight of the hopper on the ram and read off the weight directly from the pressure gauge—the gauge is divided to allow for the tare of the hopper. When it is desired to tip the load a pair of catches on the side opposite to that on which the tipping is to take place is released and the ram is pumped up. The hopper then pivots about the other pair of catches and the ram follows up the movement by rotating on trunnions in its carriage.

Among the minor novelties at the Show there was the M.T. petrol governor exhibited by Gallwey, Paul and Barker, of 40–41, Great Marlborough-street, London, W. 1, the object of which is to maintain an

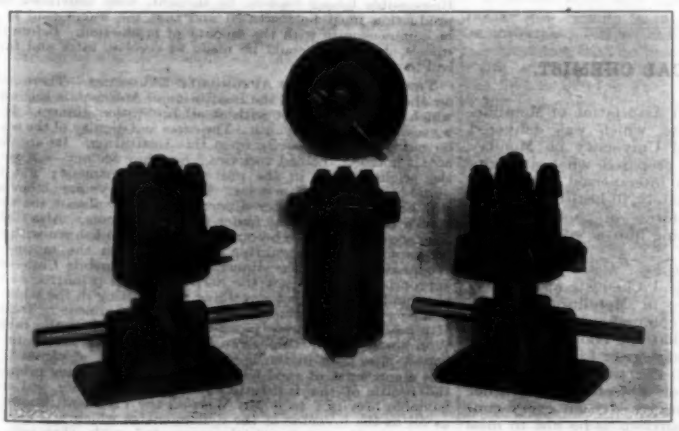


FIG. 20—AUTOMOTIVE COIL IGNITION SET

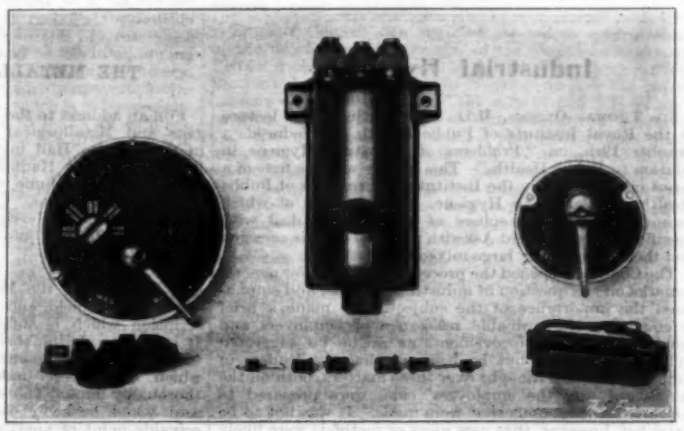


FIG. 21—IGNITION SET WITH CONDENSER, ETC., REMOVED

even quality for the combustible mixture delivered to petrol engines and also to ensure the complete vaporisation of the fuel. The device takes the form of a chamber or enlargement in the pipe leading from the carburetter to the engine. This chamber has a jacket which is connected with a branch on the exhaust pipe and is thus kept warm. The mixture of air and petrol is given a whirling motion as it passes through the chamber, with the result that any unvaporised petrol is thrown out against the heated walls and is quickly vaporised. It is claimed that this sudden vaporisation creates a back pressure in the inlet pipe which checks the flow of air over the carburetter jet, weakens the mixture, and automatically corrects it to suit the requirements of the engine.

Some bushings in which graphite is used very ingeniously to provide lubrication were shown by the Automotive Products Company, of 3, Berners-street, London. These bushes are made from sheet bronze, in which small rectangular indentations are made by a rolling process. The indentations are then filled in with a graphite compound under considerable pressure. The plate is then subjected to another rolling,

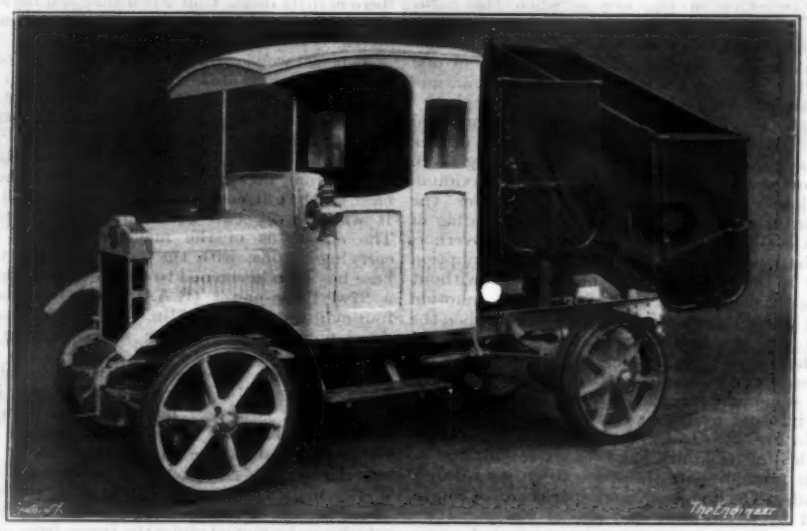


FIG. 22—TWO-TON "WAYFIP" LORRY

which expands the metal between the indentations so that the holes become of a dovetail shape and thus grip the graphite securely. Finally, the sheet is rolled up into cylindrical form, and in the process any graphite which is squeezed out of the indentations is spread out over the whole surface. These bushes are made with a high degree of accuracy and are specially suitable for such purposes as spring shackles and other services in which oil lubrication is likely to be neglected. At the same time they can be made so small that they may be used for the fine parts of cinematograph machines; the makers say, in fact, that they can make bushes by this process as thin as 0.01in.

Industrial Hygiene.

Sir Thomas Oliver, M.D., D.Sc., delivered a lecture at the Royal Institute of Public Health on Wednesday, October 19th, on "Problems of Industrial Hygiene in relation to Public Health." This lecture was the first of a series inaugurated by the Institute on Problems of Public Health in relation to Hygiene, in the course of which eminent men in this sphere of activity will deal with specific problems. Lord Askwith presided on this occasion and there was a fairly large mixed audience.

The Chairman opened the proceedings with a few general remarks on the question of industrial hygiene, and emphasised the importance of the subject. He made a brief reference to the probable resistance of employers and employed to such improvements as might be suggested in this connection, but he believed that the leaders of industry who had thought over these matters, both on the employers' and the employees' side, were prepared to welcome the proposals that were made. It was not to be expected, however, that new ideas or methods were likely to be adopted on the spot.

In his lecture, Sir Thomas said that it was in Great Britain that questions of public health first received serious attention, but industrial hygiene was still in its infancy; it was not yet organised, nor had it been given a place in the curriculum of the medical student. The well-being of the people could only be secured by attention to the laws of health. Periodical medical examination, whereby minor ailments might be recognised and treated, and the testing of men's physical fitness for work after a few months or years of factory service, would, by the elimination of the unfit, tend to maintain industrial efficiency. The present circumstances of industry, coupled with the surplus of women, made the question of the future of unmarried women of the working classes one for serious consideration, and all that could be said at present was that the field of labour for women would have to be generally extended. The neglect of vocational fitness had resulted in much industrial inefficiency and an unnecessarily large turnover of labour. It would be well if, by the institution of physical examinations, that large turnover could be diminished. No serious attempt had been made in this country to ascertain the physical fitness for work of youths leaving school; an elaborate system was in vogue in Germany, but its drawback was that it deprived the boy to some extent of the right of choice. That system did not appeal to the British mind, but the establishment of advisory boards in connection with the education authorities, and the application of tests as to physical fitness, would probably reduce the numbers of men and women now engaged in occupations for which they were not fitted.

Dealing with factory accidents, the lecturer instanced a practice introduced in America of giving bonuses for safety. Experiments were carried out in a large ironworks and in rolling mills, and the results of an investigation extending over the period 1912–1917 were published in the *Monthly Review*, November, 1919. A basing rate of accidents had been agreed upon, and if the number of accidents occurring equalled that rate the foreman received an addition to his wages. If it fell below that rate he received a larger sum, and if it exceeded it, he had no addition to his pay at all. Data of the frequency and severity of accidents in non-bonus and bonus plants were given, and the results showed that where the bonus safety system was in operation there was a considerable reduction in the number of accidents. Whereas previously workmen had been carelessly given work without careful discrimination as to their fitness for it, the foremen began to exercise greater discrimination, they saw that the men were properly trained for difficult work, and that after illness they were properly restored to health.

The question of recreation and sport was also briefly dealt with, and instances were given which tended to show that in men's recreations and hobbies was reflected their industrial capability and output. In conclusion, the lecturer pleaded for the more favourable consideration for those who aspired to higher education. One of the misfortunes of the time was that the working classes were left too much within themselves, with the result that they had no intimate knowledge of industrial and social problems other than that obtained from their own point of view.

THE METALLURGICAL CHEMIST.

For an address to the Sheffield Association of Metallurgists and Metallurgical Chemists, which was delivered in the Mappin Hall in Sheffield University on Monday last, Sir Robert Hadfield had prepared what amounts to a veritable volume which is interspersed with some excellent illustrations. Unfortunately, ill-health prevented Sir Robert from delivering his address in person, and all who know him will join in wishing him a speedy return to complete health.

The full title of the address was "The Work and Position of the Metallurgical Chemist, also References to Sheffield and its Place in Metallurgy," a description which is sufficiently comprehensive in itself. It is not wonderful, therefore, that the book, which contains it runs to some one hundred pages. Like everything which Sir Robert undertakes, the work is well and thoroughly done. The subject, or subjects we had rather said, which he has chosen are reviewed from every conceivable point of view, and so anxious is he not to miss any point which bears on them that he treats not only of Sheffield's part in the question, but of Great Britain's contribution as a whole.

Our native land, according to the tale which he unfolds, has no reason to reproach itself for the part which it has taken in developing the science of metallurgical chemistry, but rather can it congratulate itself on having been foremost in many branches of the science. The address, which, by the way, can be obtained from, amongst others, Charles Griffin and Co., Limited, Exeter-street, London, and from Mr. W. H. Steed, 50, Church-street, Sheffield, is replete with evidence that Great Britain is in no wise behind other nations in the work which it has done in connection with the furtherment of the study of metals, and that as concerns iron and steel, especially, Sheffield itself has always taken a leading part. Sir Robert, in fact, is very far from being pessimistic either as regards what British chemists have done in the past or as to what they will accomplish in future. No nationality can, he says, outvie us in the number of distinguished chemists which it has produced. Certainly, he remarks, Germany cannot, and he sturdily asserts that he has personally never felt alarmed about competition, whether mental or physical, from that country. It is true, he remarks, that the German's industry and application cover a multitude of his other sins, but declares that he sees no reason to think that he is a superior man.

The address deals with a great variety of subjects as widely set apart as wireless telegraphy and shrapnel helmets; the falls of Niagara and the Zambesi and American railways; engineers' clubs and cinematography; besides treating at length the question of ferrous alloys. Some of the subject matter has seen light before, but much of it is new, and all of it is interesting.

AN INSTITUTION OF CHEMICAL ENGINEERS.

A meeting is to be held on Wednesday, November 9th, at the Engineers' Club, London, to discuss the best method of forming an Institution of Chemical Engineers. Sir Arthur Duckham, K.C.B., will preside, and will be supported by many other representatives of various branches of industrial activity allied with the profession of chemical engineering. It is felt by those who are moving in this matter that the formation of such a professional body is an urgent necessity if the manufacturing prestige of the country is to be maintained, and its industrial efficiency increased. A corresponding American organisation has been in existence for over fifteen years, and it has expressed a willingness to co-operate with the British Institution, if and when formed, and is quite willing to give the British Institution the benefit of its own experiences in attaining maximum efficiency. It has been suggested that in the first instance a provisional institution should be formed, that membership of this provisional institution should be open at once to all chemical engineers, or those interested in chemical engineering, and that this provisional institution should proceed to form the final institution by charter or otherwise. The meeting of November 9th will be preceded by an informal dinner, and those interested are requested to communicate with Professor J. W. Hinchley, at the Imperial College of Science, South Kensington

Correction.—In the description of the Blackburn power station published in our last issue the name of the makers of the Hart air purifier was wrongly given. The makers are Messrs. Parmiter, Hope and Sugden, Manchester.

The British Electrical and Allied Manufacturers' Association.—The annual dinner of the British Electrical and Allied Manufacturers' Association was held at the Savoy Hotel on Thursday evening of last week, when the president of the Association, Lord Ampthill, occupied the chair. In proposing the toast, "The Industry," Mr. G. Balfour said that before the war they were faced with foreign competition and the establishment of agencies and works throughout the country to depress prices by design. Those tactics were about to be renewed, but he was sure that this country would overcome all the difficulties if it were given a reasonable chance. Though it was a fact that whilst wages remained at a high level, it was impossible to support the industries of the country, he appealed to employers not to reduce them to a beggarly level, but only to a standard which would enable them to find more work for the people. Mr. Ll. B. Atkinson, in responding to the toast, said that although there was a general cry for the Government to do something to alleviate the existing industrial difficulties, the industries had to right themselves and the Government could really do very little. A plain fact was that the Germans were working harder than the British or the Belgians, and it was essential that the British workman should understand that his output per hour must increase. In coupling the name of Brigadier-General Sir Henry Thornton with the toast "Our Guests," the President referred to Sir Henry's war service in connection with the Great Eastern Railway Company. Replying to the toast, General Thornton remarked that so far as the railway world was concerned, they would have no fault to find with the present scale of wages and working hours, provided they received service corresponding to the rates paid. What they needed was production. He thought the time had arrived when labour, industry and transport could pull together. Responsible labour leaders, he thought, were convinced that production must be increased and that the wages paid must be commensurate with the amount of production. Before the wheels of industry could be made to revolve, rates and fares had to come down.

The Institution of Automobile Engineers.—There is an air about the dinners of the Institution of Automobile Engineers which you do not meet with at all Institution dinners. It is, we suspect, the air of youth. The cares and dignity of the world do not yet weigh heavily upon this Institution. Its speakers are, it is true, "named varieties," but they are not—not yet—the brightest star in the post-prandial firmament; not the pintle-pins of leading articles. They are still young; they are still able to gambol after dinner. One may almost see their lamb's tails sticking out under their dress coats. Alas! that they are all doomed to become muttons and to behave with the becoming sedateness of ripe honours. Even the music—on Wednesday last at the dinner at the Automobile Club—was appropriate. For is not the harp almost as primitive as the pipe, and was there not something really fitting in the selection of nursery songs to which it was the accompaniment? Talking of pipes, too, there were pipes of another kind at the tables. Who shall gainsay that there is more good fellowship in an honest pipe than in the biggest and brightest of cigars? It was a concourse of good fellows. Sir Arthur Stanley proposed the health of the Institution in his own manner and with laudable brevity; to it Mr. Watson, the President, known to us all as the inventor of the dynamometer which was used in the recent 8h awardine trials, responded with that vein of seriousness which became the dignity of his position. Then Sir Henry Fowler arose to ask the members to toast their guests. He told us that he had thought out his speech whilst shaving himself that morning; and so another illusion broke with a snap. We had never imagined that that tonsorial adornment which is the admiration of Sir Henry's friends and the despair of his imitators could be achieved by his unaided hand. We know better now, and our admiration for Sir Henry is increased. We observed, by the way, that he has decreased somewhat his R.A.C. rating to which we referred last year, and any shorthand writer capable of doing his one hundred and fifty to the minute could keep reasonable pace with him. Then Mr. Mays-Smith spoke up on behalf of the visitors. He gave a description of an optimist which we are too modest to repeat, and having thereby brought down the house, kept it in ruins till he resumed his seat. What followed we do not know, for trains are exigent things, and we ourselves left the room to the tones of the harp whilst Lieut.-General Sir Travers Clarke was collecting himself to respond also for the guests and whilst the night was still relatively young. We had sat next to Mr. F. W. Lanchester and Mr. Clarkson, and left with the comparative merits of relativity and coke as fuel for heavy tractors ringing in our ears.

Railway Matters.

The annual report of Mr. G. P. Greene, the general manager of the Ceylon Government Railways, states, with satisfaction, that the matters at issue between the Government and the South Indian Railway were likely to be settled forthwith without further trouble.

As noted in our column of French Engineering Notes on the 21st inst., gas lighting is to be removed from all the French express trains by January 1st, 1923, and from all local trains by January 1st, 1924. The heating of local trains by means of a live coal fire is to cease within two years.

Advices from Stockholm state that the Ljungstroems Steam Turbine Company's turbo-condenser locomotive was successfully tested on October 22nd. A speed of 90 kiloms. per hour was attained, a heavy train being pulled. The new locomotive is said to effect a saving of 50 per cent. in fuel as compared with the ordinary steam locomotive.

At an inquiry held by the Light Railway Commission as to the revival of certain powers of the North Wales Narrow Gauge Railway Company and of the Portmadoc, Beddgelert and South Snowdon Railway Company, it was stated that one result of the proposals, if accepted, would be that the two existing companies would be bought out by a new undertaking, to be known as the Welsh Highland Railway Company.

It is generally assumed that a bridge built of creosoted sleeper would burn more readily, in the event of it catching fire, than would a bridge of non-treated timber. An experience with a 108ft. nine-span creosoted timber ballasted deck trestle bridge on the Nashville, Chattanooga and St. Louis Railroad on May 27th disproves this assumption. Starting at one end of the trestle and fanned by a high wind, the fire spread over the structure rapidly and burned intensely for some time. Following the fire, an examination revealed the fact that with the exception of the charring which the timbers suffered and the burning of a few braces to a degree which necessitated their renewal the structure was little the worse for its experience.

The spending of money by a railway company in pulling up its arrears of maintenance and renewal is a different matter from that of expenditure on new works. Maintenance and renewal must be kept up whatever may be the future of any railway company, and the question does not, therefore, arise as to whether or not the expenditure be justified. It differs, too, in what is perhaps a more important respect, namely, that the companies already have in their possession the monies for this work in the arrears of maintenance and renewals payments about which so much was said in the Colwyn Committee report. The companies have received 40 million pounds on this account. Most of the money is in Government securities, which, if sold, might lead to a loss. It will be interesting to see if this money and the 51 millions the companies will get under the Railways Act will be earmarked for expenditure to be put "into the road" or whether it, or part, will go in aid of dividends.

Speaking at a conference on the 18th inst. held at Olympia in connection with the Commercial Motor Exhibition, Mr. Shrapnell-Smith is understood to have said that "if the railways should get general road transport powers they would so manipulate their book-keeping that a proportion of the charge for the upkeep of their motor coaches would be entered to other headings." It may, therefore, usefully be pointed out that the Railway Companies (Accounts and Returns) Act, 1911, provides in Account No. 4 for the capital expenditure on road vehicles to be shown; in Account No. 11, for the maintenance of horse vehicles and motor vehicles separately; and in Statistical Table III., for the number of horse and motor vehicles for passenger purposes and for goods and parcels services. These returns under the Act have to be signed by the officer responsible for their correctness, who is liable to a penalty of not more than one year's imprisonment or a fine not exceeding £100 for preparing and forwarding any statement that is false to his knowledge.

According to the Board of Trade returns, the value of the railway material exported during the nine months ended September 30th last was as follows, the corresponding figures for 1920 and 1919 being added in brackets:—Locomotives, £5,924,294 (£4,008,059, £846,303); rails, £2,218,421 (£1,876,177, £1,537,458); carriages, £1,174,059 (£1,236,811, £380,711); wagons, £4,338,665 (£3,868,603, £907,465); wheels and axles, £1,379,012 (£1,405,777, £510,380); tires and axles, £1,017,811 (£996,120, £689,698); chairs and metal sleepers, £973,931 (£876,326, £266,967); miscellaneous permanent way, £2,003,272 (£1,743,730, £593,278); total permanent way, £7,780,712 (£6,990,926, £3,425,996). The weight of the rails exported was 107,838 tons (96,446 tons, 83,304 tons) and of the chairs and metal sleepers, 40,726 tons (41,040 tons, 18,555 tons). During the month of September alone locomotives to the value of £338,669 were shipped to India and of £95,780 to South Africa. During the same month rails to the value of £62,425 were shipped to South Africa, of £56,198 to India, of £45,184 to New Zealand, and of £35,449 to the Argentine.

In his report for 1920 on the railways of Ceylon, the general manager said that very little real progress was made during the year in the direction of restoring the concern to its pre-war state, and the fact must be recognised that a very considerable sum of money must still be expended before this desirable end can be attained. Unfortunately, it is an impossible matter to effect economies in working in any way commensurate with the loss in revenue resulting from the falling off in merchandise traffic, as a large proportion of the expenditure is necessary, whether the volume of traffic is up or down, more especially as the passenger traffic is keeping up well. From the force of circumstances, the department is not at present the revenue-earner to Government that it used to be, and it is a matter for consideration as to whether the charges for conveyance should be enhanced, as has been the case on most other railways over the world. The public must consider itself fortunate that, up to the present time, there has been no increase in fares and rates beyond a comparatively trifling increase in charges for coaching traffic.

Notes and Memoranda.

In the course of his latest annual report, the Inspector of Machinery for the Kimberley district of South Africa outlines a scheme for utilising the Orange River in the development of the iron ore deposits near Postmasburg. The river would, he says, give from 8000 to 10,000 horse-power, which could be used for the railways and other services besides the mines.

The Postmaster-General announces that the records which have been taken since the Toll Exchange was opened last month show that only about 5 per cent. of the total calls made throughout the day in London fail to secure immediate connection and have to be booked for completion later. The average number of outgoing calls is 5000 daily, and the incoming traffic reaches about 6000 calls per day.

In the course of a lecture on fusain, given before the Manchester Geological and Mining Society, Mr. F. S. Sinnatt said that no experiments appear to be available as to the relative explosive properties of fusain dust and coal dust in air, but, in view of the fact that this property of dust was frequently associated with the percentage of volatile matter in the material, and considering that dust containing fusain contained a lower percentage of volatile matter than the corresponding coal dust, it would follow that the presence of fusain in coal dust would render it less explosive than ordinary coal dust. On this assumption the presence of fusain tended to make the mine dust less dangerous.

During the last ten years the gas from the blast-furnaces and producers at the Pont-à-Mousson works has been cleaned by a dry process, improved in certain details by the company's engineer. The method is to pass the gas through vertical wire screens suspended in frames; the dust is shaken from the screens by an up-and-down movement, and collects in a chamber below the frames. The gas, as it leaves the furnaces, contains about 6.5 grains of dust per cubic foot, but after passing the screens this is reduced to less than 0.5 grains per cubic foot. It is claimed that the temperature of the gas only falls about 30 deg. Cent. during the process. After cleaning, the gas is led direct to the hot-blast stoves and boilers.

According to the Inspector of Mines for Natal, the impression that the supplies of good coal in Natal are inexhaustible is, on present information, anything but correct. The known supply of high-grade coal, such as the majority of that now exported, is very limited, and even at the present rate of production it will probably be exhausted in another generation. If production increases, as it must do, the exhaustion of the best Natal coal will be complete in a few years, say, forty to fifty years. In 1920 Natal produced 3,321,594 tons of coal, while in 1913 Great Britain produced 287,000,000 tons, so that Natal's present known reserves of good coal would be exhausted in less than a year if mined on the same scale as those of Great Britain.

The relatively high efficiency of the mercury arc rectifier over a wide range of output, and its ease of operation, together with extremely low maintenance, are advantages that cannot be overlooked by those contemplating extensions to their sub-station plant. When the strong position occupied by the rotary converter and motor generator is considered, the advance made by the mercury arc rectifier is almost phenomenal. That the rectifier has come to stay and will eventually largely supersede the older types of rotating converters is the opinion of those having many years' experience with such plant. The rectifier is in many ways specially suited to traction and similar conditions, and it is common knowledge to those intimately connected with them that they are so insensible to heavy fluctuations that any type of load, however severe, can be handled with the greatest ease.

A short time ago the construction of a 20,000-ton motor ship would have been too risky a proposition to undertake, but so rapid has been the progress since the Armistice that no hesitation need be felt in equipping a ship of this size with internal combustion machinery. The first 20,000-ton liner in which such plant will be installed is the new British trade ship, which is to be specially built for exhibition purposes, and to make an eighteen months' tour of the world, sailing on her first voyage in August, 1923. According to the *Motor Ship*, three Diesel engines, each of 3000 horse-power, will be installed in the trade ship, and in this instance the employment of internal combustion motors offers even greater advantages over steam than in the ordinary cargo ships. Extra space will be available for the exhibits and cabin accommodation, no funnel will be needed, and coaling will be entirely eliminated. Moreover, the propelling machinery will represent the very latest development in marine engineering, and as such will be a source of the utmost interest to visitors at the overseas ports at which the ship will call.

At a recent meeting of the Birmingham Metallurgical Society, Dr. F. Johnson contributed a paper on "The Working of Metals," in the course of which he said that the rolling of metal appeared to be complicated by so many variables as to defy at present a purely theoretical analysis. For a given condition of the metal the velocity of flow was proportional to the difference between the actual shearing stress and the yield point shearing stress. Therefore a slow rate of rolling would produce lower stresses in the metal than would a fast rate. In cold rolling 90 per cent. of the resistance to rolling was accounted for by roll-neck friction. In the rolling of metal plates and bars there always occurred an amount of lateral spread. A knowledge of the amount of spread for a given material and a given reduction was necessary, because too much spread would over-fill a pass and produce fins, whilst insufficient spreading would result in under-filling of the pass and an imperfect shape. One of the greatest factors influencing spreading was the extent and shape of the projected contact area. In rolling rods the splaying of grooves was adopted in order to produce fins of such a shape that by turning the rod through an angle of 90 deg. at the next pass the fins might be pressed back into the rod. No roll grooves were perfectly circular. Even the finishing pass allowed for a slight amount of inevitable side-spread by having the rolls left slightly apart.

Miscellanea.

Last year's export of tin from the Federated Malaya States amounted to 34,935 tons, against 36,935 tons in the preceding year.

The total production of the Indian coal mines is given at 21,000,000 tons in 1919–20, and at only 17,000,000 tons in 1920–21, a fall of nearly 20 per cent.

The pier at Buenaventura, on the Pacific Coast of Colombia, will soon be completed. Already steamers of 12,000 tons can be accommodated alongside.

The output of coal in China during last year was some 11,660,000 tons. Of this amount the province of Shansi produced the largest share of over 4,000,000 tons. The only other provinces getting more than a million tons were Chihli, Manchuria, and Honan.

According to the *Motor Ship*, proposals are being examined for the construction of a large British liner, the machinery for which must develop 24,000 horse-power on two shafts. One firm at least is said to be prepared to build two 12,000 horse-power eight-cylinder engines under the usual guarantee.

Rich deposits of tin are being worked in the region of Hoyuan, in Kuangsi, China. Another tin mine has just been opened and a tin smelting works established. It is the intention of the Canton Government to open more tin mines, and Mr. Morrison Young has been sent to Hoyuan to investigate conditions.

As soon as an opportunity occurs, Mr. Hughes will submit to Parliament proposals for Australia to participate in a scheme of direct wireless communication with Great Britain. The *Daily Telegraph* reports that the Cabinet is not unanimous as to the wisdom of spending a quarter of a million when there is a general demand for economy, but the matter will have to be debated in Parliament.

The first annual report of the Electricity Commissioners was issued on Wednesday, October 19th. Up to March last, the total amount of the loans sanctioned by the Commissioners was 15 millions sterling; 536 applications for sanction to loans were received from municipal authorities, of which 432 were granted in full or in part; and 204 out of the 284 undertakings of this class were authorised to carry out extensions.

Two technical reports were issued by the Aeronautical Research Committee on the 24th inst. One deals with dope solution tests and the other with the application of the dimensional theory to "notched-bar impact tests." The former refers to the uses of glycerol as a standard substance in viscometry, and the latter contains a diagram of apparatus for giving more consistent results in research work and for routine tests.

Two schemes for the improvement of the port of Shanghai are being considered by the Whangpoo Conservancy Board. It is considered possible that within the next twenty years a draught of 40ft. of water may have to be provided, and the alternative schemes for this purpose are dredging the Fairy Flats in the Lower Yangtze estuary for a distance of 10 miles, or the cutting of a 30-mile canal into Hangchow Bay. In both cases the silt-laden nature of the water would be a serious obstacle, and in the latter scheme a large rise and fall of tide would have to be contended with.

According to the *Indian and Eastern Engineer*, some Chinese capitalists from abroad are organising a huge company with a capital of 150,000,000 dols. It is proposed to establish a tea factory in Fukien, a sugar manufacturing and refining company in Kwangtung, a silk factory in Chekiang, cotton mills in Kiangsu, and a bank in Shanghai. Besides these enterprises, says the report, these ambitious capitalists are going to open a steamship company and a mining concern. The sole object of the proposed organisation is to manufacture and export native products and to import foreign machinery.

The Air Council has signified its warm appreciation of the decision of the Council of the Royal Institute of British Architects to award the Grissell Prize this year for the best design of an airship mooring mast. The prize consists of a gold medal and the sum of £50. The competition is open to architects who are British subjects and have not been in professional practice for more than ten years. As a further indication of its interest in the competition, the Air Council has asked that facilities shall be given it to see the more promising designs submitted by competitors, and expresses its readiness to nominate an expert to give his assistance to the Grissell Prize Committee on any points in which actual airship experience would be of value.

The Commission which was appointed in June, 1919, to investigate the question of establishing free ports in Norway has now handed in its report. The Commissioners are of opinion that, in view of the great expense involved, it is necessary to restrict the construction of such ports to the most important and most suitable towns. The respective merits of Christianssand, Stavanger, Bergen, Trondhjem and Christiania were considered, and the Commissioners find that the last-named offers the best conditions for the establishment of Norway's first free port. It is estimated that the free port would cost about Kr. 31,000,000, not including warehouses, &c. The permanent connection with the town by means of railways and bridges would cost about Kr. 8,750,000.

In reporting on the large number of separate electric lighting installations which are to be found in Rosario, Santa Fé, the United States Consul there remarks that they should prove of interest to the exporter, as consumers of lubricating oil, belting, lamps, and accessories. Both British and continental lamps are competing with American makes. The size of the various plants varies from 18,000 kilowatts (Rosario) down to 15 kilowatts in small outlying towns. Only eight are three-phase alternating-current plants, four of which are at Cordoba. Three plants at Cordoba work at 60 cycles, and the other five alternating-current plants are 50 cycle. One of these three-phase 50-cycle plants is on the Lules River at Tucuman, and develops 3750 kilowatts; another is the central plant at Rosario. Practically all the small plants burn wood.

SOME AMERICAN OIL-PUMPING ENGINES

(For description see page 460)

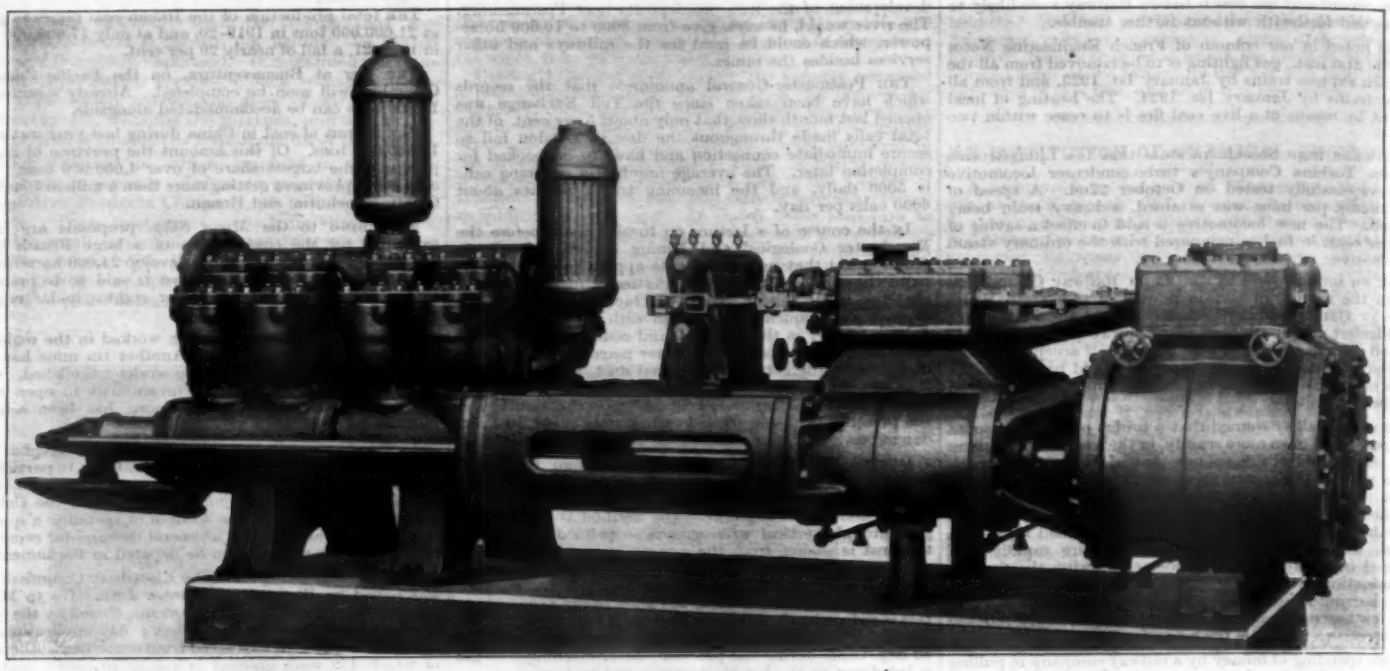


FIG. 15—DUPLEX TANDEM COMPOUND ENGINE

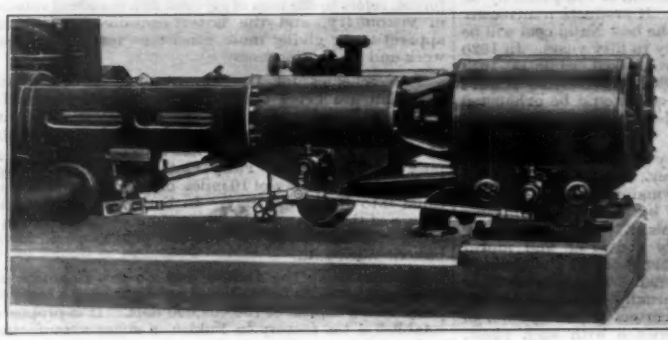


FIG. 16—TANDEM ENGINE WITH SEMI-CORLISS VALVE MOTION

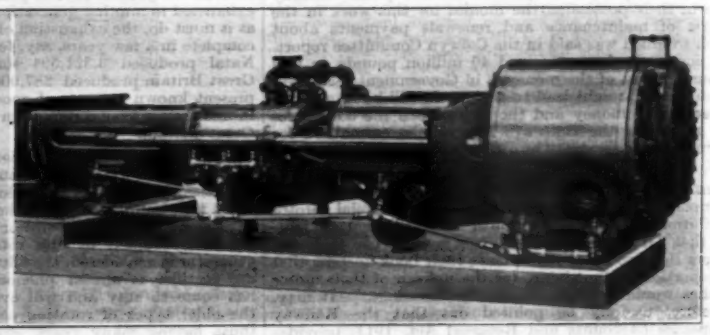


FIG. 17—DUPLEX TRIPLE-EXPANSION ENGINE

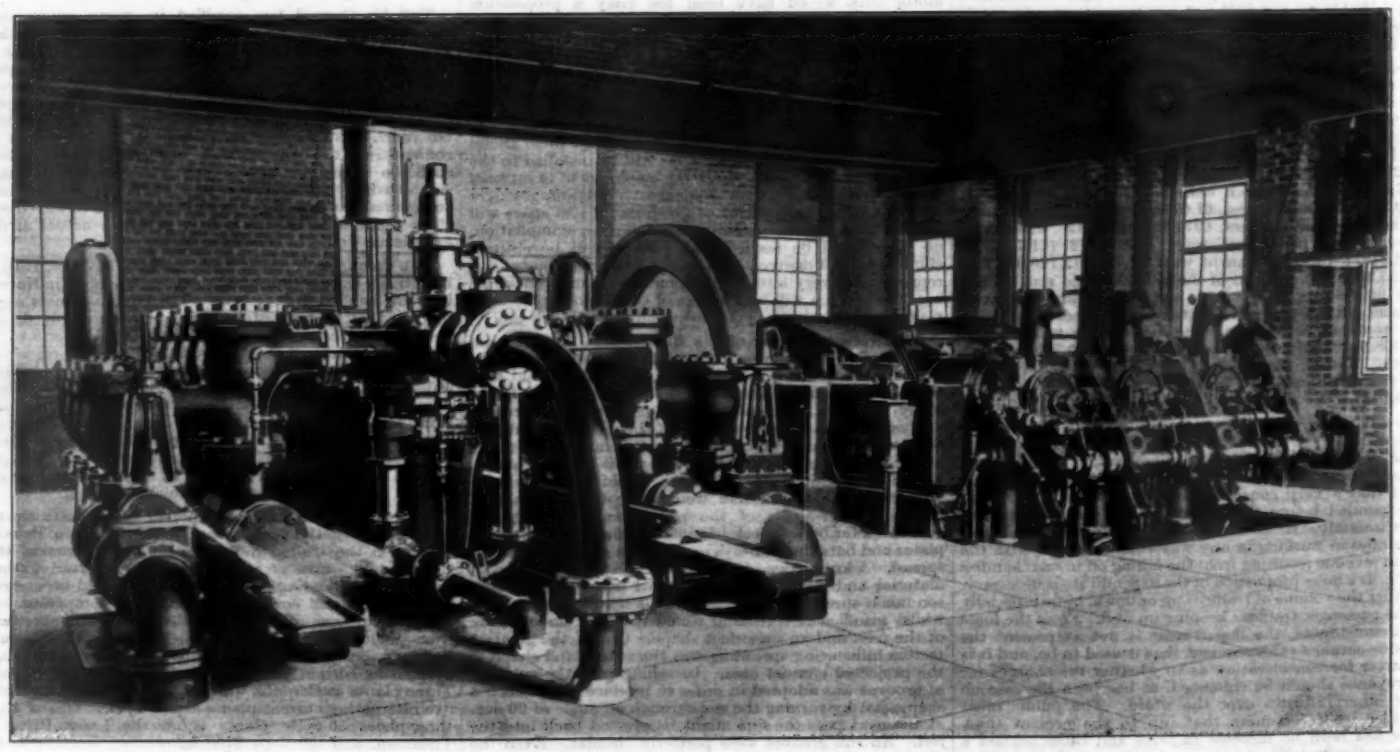


FIG. 18—270-H.P. DIESEL ENGINE AND GEARED PUMPS—YARHOLA PIPE LINE

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The Engineer.

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CHINA.—Kelly and Walsh, Limited, Shanghai and Hong Kong.
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THE ENGINEER.

OCTOBER 28, 1921.

Aluminium Alloys as Substitutes for Steel.

To the casual observer the series of researches on light aluminium alloys and other metallic combinations of low specific gravity carried out during the past ten or twelve years on behalf of the Alloys Research Committee of the Institution of Mechanical Engineers may appear in large part to be of very restricted practical interest. The work was begun before the war and was continued throughout the period of hostilities almost entirely because of its bearing upon the construction of aircraft and aero-engines. That it was justified in this respect cannot be disputed, for it contributed in no small measure to the attainment of our superiority in the air that was one of the decisive factors of the war. With the aircraft industry in a moribund condition and showing little sign at present of revival, the critic may say that the value of the Committee's work lies in the past and in a problematical future. Such a view of the situation is, we think, entirely a mistaken one. It may be admitted that the aircraft industry has little in common with other branches of engineering activity, and that the dominant necessity of saving weight that pervades it calls for methods and materials of an exceptional nature. But that the value of the Committee's recent work on light alloys is in any way confined or even of chief importance to aeronautical construction cannot be accepted as an established fact. The metallurgist has now virtually completed his scientific work on the alloys. It remains for the engineer to investigate their practical worth and application, and it will indeed be surprising if, in the course of time, he does not find important and extensive uses for some of them far outside the sphere of aeronautics.

When aluminium first became a commercial metal strong hopes were held by those interested in its manufacture that it would form a serious rival to steel for many engineering and constructional purposes. As is well known, these hopes were never realised for the reason that whereas the metal has only one-third the weight of steel, it has also only one-third its strength. Thus of two structures having the same strength, that built of aluminium would have just the same weight as that built of steel and would expose a considerably bigger surface to the action of wind pressure, corrosive influences and so on. Steel, therefore, remained unshaken in its position as the dominant engineering material. Prolonged research has now, however, established the fact that aluminium, like iron, has the property of being profoundly influenced in its characteristics by the addition to it of relatively small quantities of other metals, so much so that, again like iron, its alloys are virtually new metals. Of these new metals, Dr. Rosenhain and his colleagues have investigated a large number in a very complete manner. Among them are some little heavier than pure aluminium which have strengths at least equal to that of good mild steel, and which are quite suitable for commercial manufacture and use. Certain of the new alloys, such as that containing 4 per cent. of copper, 2 per cent. of nickel and 1½ per cent. of magnesium, have already been used in practice under exacting conditions, and have apparently given satisfactory results, for example, in airship construction and for the pistons of aero-engines and Diesel engines in submarines. That the uses to which these alloys have so far been put exhaust their practical possibilities we cannot believe. The possession of a metal of the same strength as mild steel, of less than half its weight, of equal fatigue-resisting capacity, showing a high degree of permanency and satisfactorily resisting corrosion, seems certain to open up a wide new field of possibilities in the way of engineering design. Wherever weight of structure or the inertia of moving parts is a factor of more than minor importance there will it be worth while for the engineer carefully to study the possibility of using one or other of the many light alloys of which we now possess very full metallurgical information. It is not, however, solely on the ground of their low specific gravity that the alloys deserve our attention. Their thermal conductivity, the variation of their strength with rise of temperature, the comparative ease with which they may be manipulated by the extrusion and other processes and the manner in which they may be hardened are points in which they differ notably from steel, and by virtue of which their use in various circumstances may be highly advantageous. Indeed, the low specify gravity of the alloys should no more be regarded as essentially their characteristic feature than should stainlessness be in connection with high chromium steel alloys. The first are not merely modified brasses or bronzes of low weight, nor are the second merely steels that will not rust. Both series of alloys are properly to be thought of as essentially new metals in all respects, requiring a new technique on the part of the workman and the designer alike.

We do not anticipate that common mild steel will be eclipsed in the engineer's favour by the advent of the new alloys. Even though technically a certain aluminium alloy was found to be superior for a certain purpose to mild steel the question of relative cost would still have to be considered, and would, we fear weigh heavily against the non-ferrous material. Aluminium, it is true, is the most abundant metal in the earth's crust, but it suffers from the disadvantage that, at present at least, the ores from which it is possible in practice to recover it on a commercial basis are comparatively few and narrowly distributed. Improvement in the means of its recovery, and therefore a reduction in its cost to the consumer, may reasonably be anticipated, but under the spur of a serious rival there can be no doubt that the cost of producing iron and steel would also be brought down. At present, with aluminium at £110 per ton, the new alloys, we might expect, could be obtained for about £150 per ton, for in all cases the other constituents of the alloys, such as copper, zinc, nickel, silicon, manganese and magnesium, are either considerably cheaper than aluminium, or enter into the composition in financially, though not metallurgically, insignificant amounts. The price of the alloys would thus be materially less than that at present quoted for stainless steel, but it would still be vastly greater than that of mild steel; in fact, about twelve times as much at to-day's prices. Even, therefore, if we take into consideration the fact that only a half to a third of the weight of metal is required for a structure of equal strength, the expense involved by the use of an aluminium alloy in place of mild steel would, at present at least, prove prohibitive in many cases, if not in all. It will be seen, then, that while in one respect the metallurgist's work in connection with the new alloys may be said substantially to be finished, in another it has hardly begun, for it is clear that until he can devise processes whereby aluminium can be produced with profit at a tenth or less of its present price the outlook for the extensive engineering use of the alloys, valuable and interesting as their technical properties are, must remain overclouded by purely commercial considerations.

Extrusion.

The production of bars and rods, and even of fairly complex sections, by the simple process of forcing heated metal to flow out of a cylinder under intense pressure through a suitably shaped aperture, is extremely fascinating. Not only does it capture the imagination by the sense of power which it affords when we see some of our strongest and most resistant materials forced to flow thus smoothly and apparently simply into any desired shape, but it also makes a powerful appeal of an intensely practical

kind on account of its evident economy. All the laborious and costly operations of rolling, and particularly of section rolling and drawing, are eliminated. It appears to be merely necessary to cast an ingot of the right shape, place it, suitably heated, in the container of the press and—turn on the power. True, the presses required for the process are heavy and expensive, but in return they yield a very high output, and under war conditions, where intensely rapid output was needed, the extrusion process gained a great deal of ground. It now remains to be seen whether it can rightly hold the province thus won.

At first sight this would appear to be mainly a question of economy of production, and on that score it would seem that the extrusion press stands well above any alternative process. Furthermore, there are materials, and special sections, which can be handled by extrusion, and by no other method. Thus there are alloys which can only be made into tubes by this process, at all events so far as the earlier stages of manufacture are concerned. So attractive, indeed, is the process from this point of view that the production of tubes of certain difficult types of steel is being seriously tried by means of the extrusion press. Compared with rolling, of course, the process is still relatively young, and it still suffers from some of the troubles of comparative infancy. There are still difficulties with rams that do not stand up to the maximum pressures required, and dies that split or distort. Yet on the whole, from the production point of view, the process has undoubtedly "arrived." For a large number of purposes for which some metals, and more especially some of the cheaper kinds of brass, are employed, the production point of view is the most important one, for little or nothing is demanded of the product but good external finish, which can be readily obtained by extrusion. But when the products are intended for use as materials of engineering, quite other considerations enter into the question. There is, of course, a school of thought which would be completely satisfied with any product which could pass the usual specified tests as required in the case of rolled or drawn material, without reference to its mode of production. But such a view is based on a misconception of the real function of testing materials, and in the case under discussion might easily lead to serious results. Fortunately, it is well known that extruded material is liable to contain serious internal longitudinal flaws, whose presence might not be disclosed in ordinary tensile test figures. Other methods of testing and inspection are, therefore, regularly applied to extruded products, and, as a rule, although not always, they succeed in detecting such defects. The cause and nature of these internal defects and possible remedies have recently received much discussion, a discussion, by the way, in which the larger manufacturers of extruded materials conspicuously failed to take their proper share. One result of their ill-timed reticence is undoubtedly to strengthen the doubt already existing in the minds of some engineers as to the true reliability of extruded material where strength and toughness are essential. Still, the investigation of the nature of these defects, and of the best methods of avoiding them, may well be left in the hands of our metallurgists, both scientific and practical. What the engineer has to consider—and we feel that he ought to consider it carefully—is whether and for what purposes he should permit the use of extruded metal. He must, in the first place, assure himself that the tests included in his specifications are such as to exclude, with reasonable certainty, all really faulty material, and he must then satisfy himself that at its best and soundest extruded metal is as good in every way as the rolled or drawn product. Neither of these steps is easy or simple at the present time, and it would seem that those who are concerned with the manufacture and sale of extruded material should secure the services of the scientific metallurgist to clear up the whole matter and to publish data which shall serve to establish the true status of their products. The devising of adequate tests is, perhaps, the simpler matter of the two. The internal flaws of which we speak are, as a rule, clearly seen when a notched bar is broken by a blow. Unfortunately, it would seem to be necessary in the present state of our knowledge to apply such a test, or rather a number of such tests to every bar which is to serve for important uses. Only when the causes and nature of this defect are more thoroughly understood shall we feel perfectly safe in relying upon the indications of a very few tests of this or some similar nature.

Here we have one of those cases where confidence in the process and the product on their own account is essential if a reasonable amount of testing is to be accepted as satisfactory. It is the affair of the manufacturers to establish that confidence. But even if it be accomplished and the occurrence of palpable defects in extruded metal be reduced to a point where it can be neglected for practical purposes, the question will yet remain whether the process yields material as tough and reliable as that produced by other means. This is a deeper question, for the extrusion process undoubtedly subjects the metal to a series of physical stresses which differ widely in character from those involved in rolling and drawing. In extrusion the whole reduction of cross-sectional area is carried out in a single high-temperature operation. The flow is, no doubt, sufficiently severe to break down the original crystalline structure of the metal, but the change of shape is very sudden and little loss of heat occurs while it is in progress. The "worked" or "flowed" metal is thus given ample time, as a rule, to undergo re-crystallisation or self-annealing. The product is, therefore, usually much more akin to hot-rolled than to cold-rolled or cold-drawn metal. This, in itself, is no disadvantage for many purposes and a decided gain for some, but it remains to be established that the beneficial effects of "work" are as well secured by this single and extremely drastic operation as by the slower and older processes. To settle such a point, extensive series of comparative tests would be needed, including notched bar impact and alternating stress (fatigue) tests. By such data alone can those interested in extruded products hope to convince the careful engineer who looks for toughness and reliability in his materials and is not prepared to sacrifice his certainty of these qualities for the attractions of cheapness and good surface finish.

Literature.

Eleventh Report to the Alloys Research Committee of the Institution of Mechanical Engineers; on Some Alloys of Aluminium. By Walter Rosenhain, D.Sc., F.R.S., Sydney L. Archbutt, F.I.C., and D. Hanson, D.Sc. Published by the Institution of Mechanical Engineers, Storey's-gate, Westminster. Price £2 2s.

This volume treats in a concise way with the results of a lengthy investigation of the properties of certain light ternary alloys of aluminium. In the first and larger part of the book the relationship between the composition and the physical properties of the alloys, combined with the conditions of use, are given in a systematic and most comprehensive manner. As a first great subdivision, we find cast and wrought alloys as headings.

Cast Alloys.

From a practical point of view, alloys of Al, Cu and Zn are the most important ones, and a beginning is made by showing the variations of tensile strength of these, with Cu at 1, 2, 3 and 4 per cent., and gradual variations of zinc from 1 to 35 per cent. Two distinct sets of curves are given, one for sand castings and another for chill castings. There is a surprisingly small difference between the tensile strength curves for the two classes, which are almost straight lines, when Zn varies up to 25 per cent. Copper up to 2, 3 and 4 per cent. seems to have about the same effect on the tensile strength, but that constituent decreases the elongation considerably as the percentage increases, which is, of course, well known in foundry practice. The yield stress diagrams for the sand castings are from the nature of the test somewhat irregular, but for chill castings the ratio ultimate strength to yield point was found to augment gradually with the zinc. The logical outcome of this series of tests is to support the well-known L 5 specification.

It is difficult to understand the small difference established between the sand and chill castings, both as regards tensile strength and density, but it is satisfactory to note the fact as showing that strong sand castings of this kind are within the range of possibility. Following a discussion on micro-structures, the alteration of tensile strength with increase of temperature is treated for various alloys. Here we are shown the most extraordinary fact that for many alloys the elongation increases with temperature, and that for CuMn alloys with 1 per cent. Mn the tensile strength also increases up to 250 deg. Cent. As Mn decreases the actual value of the tensile strength at ordinary temperature to some extent, an alloy called "Y" is introduced at this point. This alloy, containing Cu 4 per cent., Ni 2 per cent. and Mg 1.5 per cent., has a tensile strength of not less than 12 tons per square inch at 250 deg. Cent., and a slightly higher elongation than the manganese alloys. For the construction of pistons this alloy "Y" should be very satisfactory, if its casting properties are good, which undoubtedly is not the case with alloys containing Mn. The whole of this chapter is full of interest and should lead to practical trials, as the 88/12 Cu/Al binary, which is generally used for pistons, is far from satisfactory. A curious thing is that 0.7 per cent. vanadium and 1 per cent. iron were found to increase the strength of Cu alloys with temperature like Mn. The final part, relating to castings, treats of the contraction on setting, and shows variations from 1.42 to 1.19 per cent.; hence the mean agrees closely with 1 part in 77, which is used in foundry practice.

A discussion of heat treatment of castings follows. The experimental results show a distinct increase of both tensile strength and elongation. This is, of course, of great interest, but the practical man wants to know what kind of deformation takes place with more or less intricate castings, when subjected to annealing. In the past, particularly during the war, the closeness to dimensions required in die castings was so great as to prevent even the trying out of such processes, although good results were otherwise expected. In a later part of the report under review, stability of dimensions of actual castings with ageing is demonstrated, and one would have thought that something similar might have been done with regard to the effect of annealing.

Wrought Alloys.

A beginning is made with a similar series of CuZn alloys, as in the case of castings. The researches treated as an introduction to the subject refer to work done in overcoming the difficulties of breaking down alloys, rich in Zn. To anybody who has devoted years to the study of rolling "difficult" materials, it is interesting to see history repeat itself. Rolling of alloys is not as easy as rolling pure metals, and hot breaking down of alloys is always somewhat tricky. In this case, we find that first compression by swaging under the hammer was resorted to, and that finally an improved method of casting in tilted chills was found to work wonders. From a practical point of view, hammer compression would, on account of cost, do away with the advantage of cheapness aimed at, judging by the composition of the alloys examined. It is also a most delicate operation, and, as such, uncertain. Rolls must be used from beginning to end, and if the alloy will not stand rolling, then it will have to be altered till it does. The remark that the nature of the original casting is of vital importance is quite correct, and the reviewer also believes that tilting of the chills is advantageous, but in practice as good results can be obtained by the use of vertical chills. Both methods are used for other purposes with equal success in different foundries. The authors' departure into details of this kind, is, however, quite interesting, and as the experiment led to the erection of a small plant at the National Physical Laboratory, they certainly served a useful purpose. The main object was not to devise a rolling process, but to determine the properties of rolled specimens of CuZn alloys.

As with castings, the results show an increase of tensile strength with increasing percentages of zinc. The copper also improves the strength in the same way, but it diminishes the elongation proportionately, although not out of reason. Hardness, according to Brinell and by the scleroscope, follow suit, as does the elastic limit. On the other hand, hard drawing diminishes the elongation without any great increase of strength in old specimens, and some 20 to 24 per cent. on new ones. This effect of ageing in increasing the tensile strength of these alloys so much is of great interest, as it was noted after not less than ten years of storage. The results of alternate bending tests remain good, even for alloys with 25 per cent. Zn. As a general conclusion, the authors find that the alloy with 20 per cent. Zn and 3 per cent. Cu is of importance, and here the reviewer agrees with them. It assumes in ¾in. hot-rolled rods a tensile strength of 27.5 tons per square inch, with an elongation in 2in. of 18 per cent. after ten years' storage, beginning with some 20 per cent. lower tensile strength. The authors consider that this is the highest percentage of zinc to permit successful rolling. On this point the reviewer differs from the authors, as he deems it too high for rolling, but suitable for extrusion. The authors seem to dislike the latter method on account of the occurrence of longitudinal lamination, which undoubtedly occurs when the speed of extrusion is unsuitable. This by the way. As a distinguishing mark, the alloy carries the letter "A."

Up to this point rolled bars were used for tests, but the authors proceed to describe their experience with flat rolling of "A" and other mixtures. As might be expected, the tests for thin gauge sheets of "A" came out somewhat higher than those for rods. It is interesting to note that spinning of the sheet metal was tried, and successfully carried out after some experiments which gave an optimum annealing temperature of 250 deg. Cent. Experiments were also carried out with very thin sheets to be used for aeroplane wing covers with good results. The investigations were extended to the influence of small additions of Fe, Ni, Mn, Mg and Si to "A," and an alloy "E" was evolved, containing Cu 2.5 per cent., Zn 20 per cent., Mn 0.5 per cent., Mg 0.5 per cent., with a stipulated 0.2 per cent. maximum for Fe and Si. The diagrams of stress and yield for this alloy, as given, are truly remarkable, the deformations being elastic for stresses well above 30 tons per square inch in the case of extruded rods, before and after subsequent rolling. This alloy proved to possess an optimum forging temperature of 350 deg. Cent., at which point 30 per cent. reduction of thickness could be got without fear of cracking. Quenching from 400 deg. Cent., and ageing, brought the tenacity to almost 40 tons per square inch, with an elongation of 11 per cent. In this case the only fault of alloy "E" seems to be an admitted difficulty in working it. Introduction of silicon and zinc with

a slight diminution of magnesium and manganese seemed to improve matters, and two alloys "F" and "G" were developed on these lines.

There is no doubt that these alloys form a great advance over anything used as yet in general practice, and great credit is due to their originators. Practical difficulties in rolling, extruding and drawing can undoubtedly be overcome in commercial mills under experienced management, once the tendency to conservatism, characteristic of the members of the metal trade, is overcome. The previously mentioned alloy "Y," containing Cu 4 per cent., Ni 2 per cent. and Mg 1.5 per cent. can be rolled and forged fairly easily, and this forms more of *a fait accompli*. Its property of losing tensile strength very slightly with rise of temperature, and, as the authors point out later, its great resistance to fatigue under alternate stresses, besides its small tendency to develop ageing cracks, make this alloy a great acquisition to engineering. The tensile strength of "Y" is, after all, similar to that of duralumin, which loses strength rapidly with increase of temperature, and the alloy ought to be given a serious practical trial.

When reading this extremely interesting account of all these experiments, one must admire the power of initiative of the authors, as well as their flexibility of mind, when they are following up certain clues in the form of minute variations. One may differ from them on details, but the more one has worked on similar questions, the more one hopes that all this work may not be "Love's labour lost." Apart from defining their optimum as arrived at immediately, the authors have also studied influence of time alone, as well as that of time and stress. Prolonged storing seems almost without exception to have increased the dimensions of castings somewhat, the maximum amounting to some 0.03 per cent. Against one of these cases is marked "overheated," which conveys a vast amount to those accustomed to casting aluminium alloys. The tests for fracture under prolonged stress seem to indicate a trifling tendency to "season cracking" of the A, E, F, G series, but on the whole one has seen worse cases with steel and other materials.

In the following chapter on corrosion the authors give some results relating to the state of the alloys after immersion in sea water. These results confirm what is well known, viz., the closer the alloys approach to pure aluminium, the better they are. Pure aluminium stands this class of corrosion immeasurably better than any alloy known. With this somewhat condensed review of the practical part, the reviewer must reluctantly leave this most brilliant *exposé* of what can be done by the time-honoured method of trial and error, to turn to the theoretical part.

Constitution of the Alloys.

The authors state in the introduction "that such success as has been attained in the development of the various groups of alloys would not have been possible without a concurrent study of the alloys from the theoretical side, and the information and guidance which that study provided." It would have rendered great service to mankind in general if the authors had emphasised the relationships between characteristic points in the diagrams of thermal equilibria with the physical properties of the alloys themselves at those points. One would also like to know the actual significance of the appearance of certain structures under certain temperature conditions with regard to the behaviour of the alloys, &c. As means of proving identities and tracing previous treatment, microscopic examination goes a long way, and may thus help in retracing a lost step in the experiments, but in what way does it form an *a priori* argument? There must undoubtedly be laws in existence, but have we as yet found any? The authors start with a *postlo* that the molecular compound Mg_2Si is the hardening agent in the duralumin group, to cite an example. This may be, but in commercial duralumin manganese plays an important part, and it does not vary in quantity to anything like the same extent as the magnesium. From the authors' own showing, Mn and Mg play a similar part with reference to Al, Cu alloys. Conclusions in this line are always open to *tertium datur*, and equally conscientious investigators may arrive at different results which may be equally true. But to continue. The authors first elaborate a solid equilibrium diagram of the ternaries Al, Zn, Cu, and this is finally illustrated by a model produced by rectilinear generatrices. Eutectic points become lines or surfaces, and surfaces of structural similarity become volumes. This mode of illustration is, of course, very good, and represents the state of knowledge of the equilibria, studied so far most excellently. Si, Mg, Al alloys are treated in the same way, and another model is produced of entirely different nature. Speaking mathematically, these solids are produced by movement in one direction of a binary surface with uniform increments of the third constituent and simultaneous development of the characteristic points into lines or surfaces, and defined surfaces into solids. Mathematically, this is simplicity itself, but the various projections require a rather close study. In some cases they give rise to asymptotic curves by transference of one set of branches of the ordinary bi-axial projections in a triangular system of co-ordinates. An actual attempt at an algebraical interpretation is not made, but it ought to be possible, in as far as the lateral movement of the binary system is concerned, as the surfaces generated appear to be continuous.

In the following discussion of the influence of molecular compounds on the properties of the alloys, the authors revert to percentage diagrams, as in the beginning of the work. The treatment of this theoretical part is extremely brief, from obvious reasons, but the illustrations give a fair indication of the amount of work done, which must have been enormous. One must applaud the method of employing models with generating lines shown in perspective, as the usual triangular diagrams require rather too much of one's imagination. The theory of solid solutions as applied to metallic alloys is in itself a difficult subject on account of the absence of any universal criterion, like, for instance, transparency in the case of glass, or the appearance of crystals which can be watched in an ordinary transparent solution. Everything has to be done by inference from thermal phenomena, and a final appeal to the microscope. All the same, a huge amount of work has been done, and there is abundant material for a coming generalisation. The authors of the work now reviewed deserve great thanks from their fellow-workers in metallurgical research, and from the public in general for this last contribution to knowledge.

Obituary.

CLEM D. WEBB.

The latest journals from South Africa announce the death, on September 19th, of Major Clem D. Webb, M.C., the proprietor of the *South African Mining and Engineering Journal*. Mr. Webb was born at Fort Peddie nearly fifty-nine years ago, and was the son of the local magistrate, whose family had gone out to South Africa in 1820. He was educated at Rondebosch, and qualified as a solicitor at the Supreme Court at Cape Colony. In 1886 he was appointed by the Cape Government to take charge of its exhibits at the Colonial and Indian Exhibition in London, but on his return took up stockbroking for a time, while he spent some time as a native labour contractor and as a lawyer. Mr. Webb always took a keen interest in local politics, and was one of the four leaders of the South African League, which was formed in 1899 to support the independence of the Uitlanders. That was, of course, in the days before the Boer War. He assisted to form the Imperial Light Horse, which distinguished itself in the Boer War, and although well over military age, he received a commission as Transport Officer in German East Africa during the recent war. After the successful completion of the East African campaign, Major Webb took command of a native labour contingent in France. Mr. Webb married Miss G. E. Pretorious, a descendant of the President of the South African Republic, and leaves a family of six sons and three daughters.

Factors Necessary for Highest Engineering Success.

By A RAILWAY ENGINEER.

Under the above title there appeared in the issue of The Engineer for July 15th, 1921, an extract from an address by Mr. Ira O. Baker, M. Am. Soc. C.E., to the Pardue University Student Chapter. Not only students, but engineers of every age and standing might well devote a few minutes to a study of this address, which is not only an epitome by a clear-sighted and clear-thinking man of the qualities which are necessary for success in a profession which, above all, requires clarity of vision and thought, but is also an inspiring call to youth for a high ideal of efficiency in the public service, since success in engineering, as in other professions, carries with it not merely honours and monetary reward, but a solid achievement of service for the public good.

The lecturer named five factors which are fundamental of success:—

(1) Technical ability.
(2) Breadth of knowledge.
(3) Initiative.
(4) Executive ability.
(5) Ability to write and to speak.

These are all within the student's grasp, if he will but apply himself to their attainment, but a factor of almost equal importance—which is not mentioned, probably for the very good reason that it is beyond his control—is opportunity, and it is on this subject that the writer would like to say a few words.

If a successful engineer possesses Mr. Baker's fifth and last qualification, nothing will be easier to him than to address an audience of young engineers on the factors to which he owes his success, and, if he possesses modesty as well, he will probably not omit to make some reference to the particular circumstances which enabled his qualities to be recognised at the right time, and to the qualities in his employer or superior officer who gave him his first promotion.

Unfortunately, many youngsters of great ability are passed over, temporarily or permanently, owing to the lack of one or more of the five qualifications enumerated by Mr. Baker, not on their part, but on the part of their employers. The greatest test of executive ability is the capacity for judging men, training a staff and organising their work, so that not only is there the right man for each job, but a sufficient number of men in training to fill vacancies or to allow for expansion of business. The presence of the qualification of executive ability, together with breadth of knowledge, in the character of his employer may well constitute the opportunity factor which completes the student's success. The absence of these qualities may easily spell partial failure at least to a youth of brilliant promise.

In dealing with a staff of assistants, it is not always easy for the superior officer to draw the line finely between his duty to his firm, his duty to the staff and his own convenience. According to his conscientiousness, his actions are determined. With some men the firm's interests alone are considered. With others, it almost appears that they consult nothing but their own convenience, and both the firm and the staff go to the wall. It is certain, however, that the executive officer who has a capable, well-trained and satisfied staff will be in the best position to serve his firm's interests and also to enjoy his own work.

Our civilisation is based largely on competition, national and personal. We train our boys to compete with one another in work and play; we teach them from their early years that their worldly success will depend on their ability to outshine their compeers. Even the idealist who shouts for equal conditions for all, urges his son to bring home a prize from school or perhaps win a scholarship; while the Communists are ready to compete for the post of commissary, since all cannot be commissaries. No system which ignores the human desire for reward for achievement and the striving after honour can possibly endure until this planet is re-peopled with a different race of men.

Competition, however, which would give all the prizes to the strongest is largely neutralised by the principle of promotion by seniority, and the extent of this process is the main difference between the methods of private concerns and those of Government Departments. When an administration is of such a size and complexity that the executive chiefs lose touch with their staff or where political and social intrigue is feared, the tendency is strong to promote by seniority and not by absolute merit.

If the seniority system were definitely and universally adopted, it would be of little use to exhort our youths to attain initiative and technical ability above their fellows, and we need only adjure them to avoid misdemeanour and attain such a grade of efficiency as will enable them to retain their posts with the minimum of labour.

The writer has been told by those in Government service that the reward of the man who tries his hardest is often little different from that of him who does the least possible, and that the effect of a special effort, if it does not actually lead to unpleasantness, may easily be neutralised by the inertia of the superiors who are sure of their reward whatever their performance, and thus all initiative on the part of juniors is frequently drowned. To this cause, which seems to be almost inseparable from Government work, is probably due the costliness and inefficiency of the large staffs employed by Governments all over the world.

Nothing is sadder than to see the idealism of youth sapped by a premature cynicism, and nothing is more refreshing than age and experience whose ideals have survived the many disappointments and rebuffs which all idealists must bear, and it is, to the author, a matter of surprise and congratulation that so many of his friends seem to retain their faculty of building castles in the air long after a cynical view would demolish their airy foundation. The ideal, however, of a state where all work for the common good, without hope or desire for financial reward or for any material improvement, and where enthusiastic scientific men compete with each other for the honour of serving their generation, content with its thanks alone, is, unfortunately, or perhaps fortunately, likely to be realised anywhere but on this earth.

Whereas, therefore, it is the wisdom of youth to seize opportunity, it is the duty of age to provide it; but one often hears age exhorting youth to do its part, and at the same time failing to see how its own is left undone.

If age has not cultivated the faculties of clear thinking, sane organisation and wise judgment, it is impossible for it to give proper opportunities to youth, and thus we see a business becoming stagnant or moribund through the reins of office falling into inefficient hands.

To bring the matter down to a more practical form, the author would like to suggest the following five desirable qualifications for those who have in their hands the fate of our young men:—

(1) *Scientific and Business Ability* in a thorough organisation for training men and awarding promotion.
(2) *Confidence* in willingness to entrust responsibility to their subordinates.
(3) *Friendliness* in sympathy and close touch with staff.
(4) *Unselfishness.*
(5) *Modesty.*
} In appreciation of the necessity for co-operation and honest recognition of services rendered.

There are men who may be described as men of large heart and little head, who fail not by lack of sympathy, but by weakness and inability to recognise merit. There are others who have the ability to recognise a good assistant, but are too selfish to give him his proper place. Some are so obsessed with their own position and attainments that they try to do the whole work of their office themselves, and fail to realise how much better it would be done by a capable staff of assistants. Others, again, are successful in inspiring initiative and originality and in training a staff, but insist on acquiring the whole reward themselves.

In conclusion, one might suggest that all engineers who have the responsibility of employing or training the youth of our profession might give a thought to Mr. Baker's address, and consider whether they really are able to recognise in their staff those qualities which he so well describes, and whether they are doing all in their power to provide the missing factor—Opportunity.

On Friday afternoon last, Field-Marshal Lord Haig unveiled the memorial, in the approach from Euston-road to Euston Station, erected to the memory of the 3719 London and North-Western servants who laid down their lives in the war.

DIESEL ENGINE AND GEARED PUMP ON THE YARHOLA OIL PIPE LINE

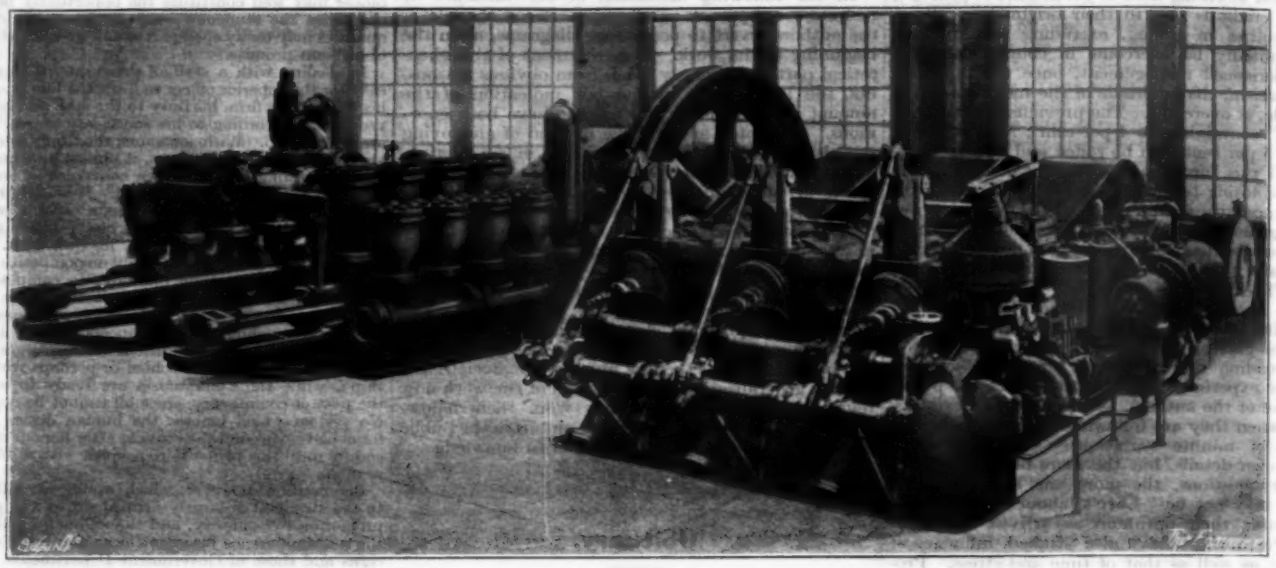


FIG. 19

American Pipe Lines for Pumping Oil.

No. IV.*

Both steam and internal combustion engines are used at the pumping stations of pipe lines, the steam plants having boilers fired by coal, fuel oil or natural gas.

A compound tandem duplex four-cylinder slide valve engine, with directly connected oil pump, is shown in Fig. 15, page 456. In some similar engines a semi-Corliss type of valve motion is used, as shown in Fig. 16, on the same page, each cylinder having a single Corliss valve placed transversely under it, with passages from the valve chamber to each end of the cylinder. The valve stems have crank arms, which are coupled together and operated by a rod connection from the crosshead. The slide valve engine has ordinarily steam cylinders, about 16in. by 24in. and 25in. by 24in., with 10in. oil pumps. In the semi-Corliss engine they are about 21in. by 36in. and 38in. by 36in. A triple-expansion pumping engine of the same general type is shown in Fig. 17, page 456. The three engines illustrated in Figs. 15–17 are types built by the John H. McGowan Company, of Cincinnati. It will be noted that in the modified Corliss valve motion no dashpots are used.

Similar engines are used extensively for pumping water, but in such case the pump end is of considerably different construction. An important difference is to be found in the valve area, the velocity of oil through the valve seats being about 100ft. to 125ft. per minute, while in handling water the velocity varies from 180ft. to 200ft. per minute. Oil-pumping engines have usually wing type pressure valves, which provide a fairly free opening through the valve seat. Another type of valve for oil is the "multiplate," in which a disc valve provides a passage, not only round the circumference of the valve, but also through ports in the centre of the valve. In recent years many oil pipe line operators have shown a preference for a solid brass ball valve, but although this form is used in pumps operated by internal combustion engines, it is very seldom applied in connection with steam-operated machines.

A compact design of horizonta triple-expansion condensing crank and fly-wheel oil pumping engine, constructed by the National Transit Pump and Machine Company, of Oil City, has its three cylinders placed side by side and driving a crank shaft with two fly-wheels mounted on either side of the middle or intermediate cylinder. From each crosshead extend rods connected to the plungers of two oil cylinders opposite the steam cylinder. This engine has the Corliss type of valve motion. Its cylinders are 24in., 40in. and 60in. diameter, and 36in. stroke. The plungers, of cast iron, are 7in. in diameter and work in cast steel cylinders. The suction opening is 10in. and the discharge opening 8in. in diameter. The maximum working pressures in this engine are 150 lb. per square inch in the high-pressure steam cylinder and 900 lb. in the oil cylinder. When running at 50 revolutions under these conditions the delivery capacity is 51,000 barrels, or 2,142,000 gallons in twenty-four hours.

A geared pump for auxiliary or reserve service is built by the same company. Herringbone main gearing is used, the pinion being on the pump side with its shaft mounted on the frame for the pump

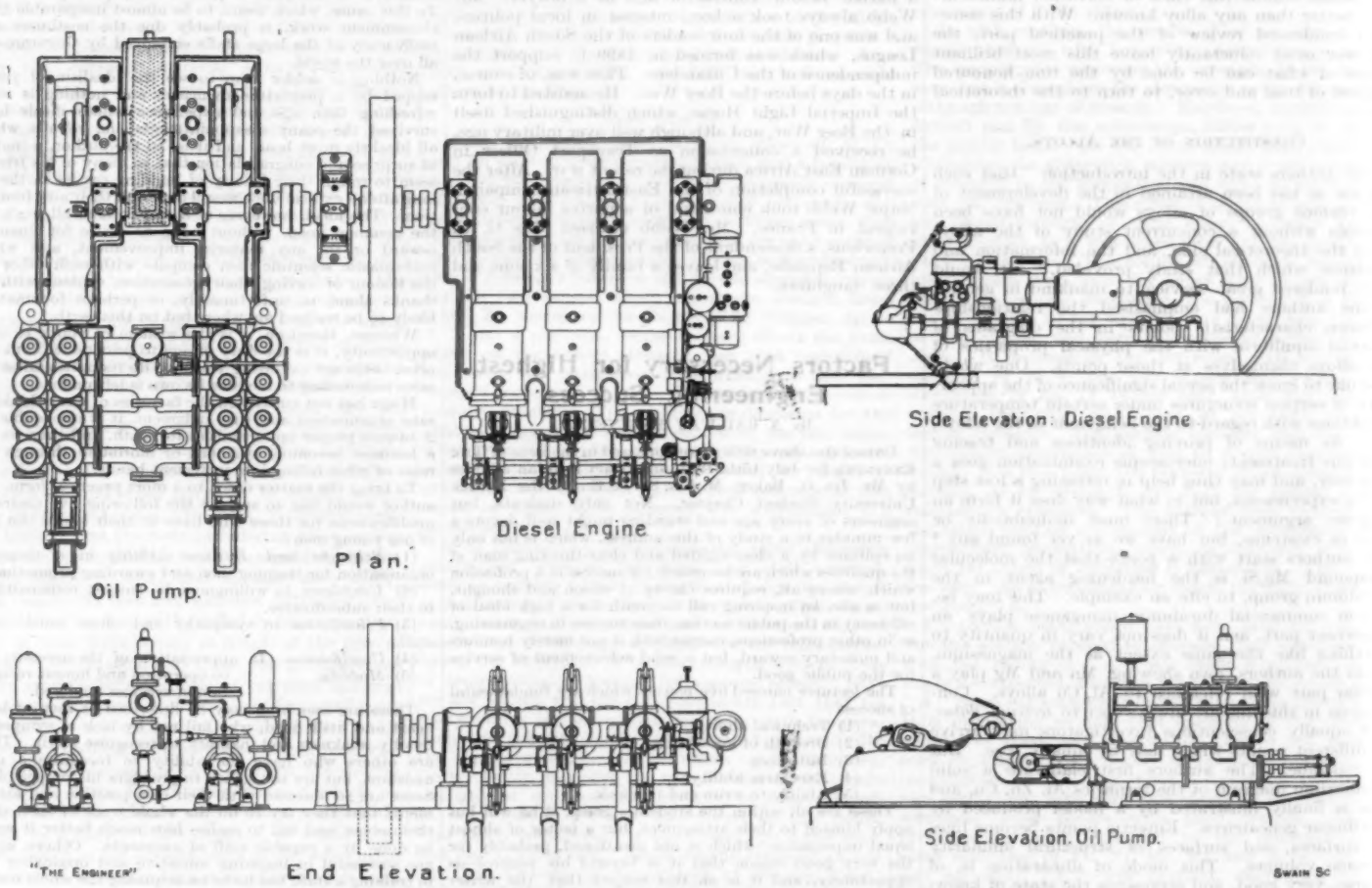


FIG. 20—GENERAL ARRANGEMENT OF DIESEL ENGINE OIL PUMP ON THE YARHOLA PIPE LINE

* No. III. appeared October 14th.

crossheads. Crank discs on the spur wheel shaft carry short connecting-rods to crossheads, from which the pump plungers are driven. With 5in. by 18in. pump cylinders and 900 lb. pressure in the force main, this pumping set at 50 revolutions per minute has a capacity of 11,900 barrels of oil in twenty-four hours.

Diesel Engines for Pumping Oil.

Although steam pumping engines are used in the great majority of cases for oil pipe lines, there is an extensive and increasing use of internal combustion engines, which latter have proved reliable in continuous service and have shown low maintenance costs.

A conspicuous example of this development is found in connection with the Yarhola pipe line, 555 miles long, which was described in an earlier article. The pipe line has nine pumping stations equipped with twenty-one Diesel engines of 270 and 180 horse-power. In the opinion of Mr. A. K. Riddle, superintendent of the line, the oil engine has many advantages over the steam engine. In the first place its fuel consumption is low, averaging only about 0.7 barrel of fuel oil—or 29 gallons—per 1000 barrels of oil pumped at a working pressure of 500 lb. per square inch. The plant further requires but a small number of men to operate it, as compared with a steam plant burning coal. In addition, there is the elimination of boiler troubles and water supply difficulties, as very little water is lost or consumed in the operation of the engines.

The two pumping stations on the first 130-mile section of the Yarhola pipe line had a daily capacity of 8000 barrels, one of them being at the head of the line in the oilfield and the other at mid-length. Two intermediate stations were built later, and new pumping plants of 12,000 barrels capacity were installed. For the 325-mile extension to East Saint Louis, five pumping stations were provided, having units of 12,000 barrels capacity. Each of these stations has three 12,000-barrel units, one of which is kept in reserve. Thus there are now nineteen units of 12,000 barrels capacity with 270 horse-power engines, and two units of 8000 barrels and 180 horse-power.

The larger oil engines have three cylinders, while the smaller have two, but in each case the engine drives a pair of pumps. In all cases the engine cylinders are 16in. by 24in., with pump plungers 5in. by 24in. The engines are run at about 220 revolutions per minute, and drive the pumps through a cast steel transmission gear of the Francke type, with herring-bone teeth. The gear ratio is 5½ to 1. At the normal pump speed of 38 revolutions, the triplex units give a displacement of 500 barrels per hour, while that of the duplex units is 334 barrels per hour. These engines and pumps were constructed by the Allis-Chalmers Manufacturing Company, of Milwaukee.

The general arrangement of one of the larger plants is shown in Fig. 20, while Figs. 18 and 19—the former on page 456—are views of one of the plants as installed. It will be seen that the shaft of the oil engine is coupled to the pinion shaft of the Francke transmission gear. Crank arms on the spur wheel shaft carry connecting-rods, which operate the crossheads of the pump plungers, these plungers being of the outside end-packed type. The valve chambers are of cast steel, each containing a bronze valve of the double annular type, with a steel removable flat-faced valve seat. Pressure relief and by-pass valves are provided to facilitate starting against the heavy load of an oil main fitted with cold oil. These valves are also safety devices. Speed control devices are fitted to all the engines. The pumps are designed for a working pressure of 1000 lb., though they are worked normally at 900 lb. All parts subjected to oil pressure were tested to 1200 lb. at the builders' works.

For successful continuous operation, the Diesel engine requires an ample supply of clean cooling water which will not cause deposits of scale in the cylinder jackets. As the water supply at all the stations on this line is of poor quality and limited quantity, it was decided to distil the cooling water and circulate it in a closed system, thus providing against scale or sediment, which would impair the cooling efficiency of the jackets. For each engine there are two belt-driven pumps, one of which maintains a circulation of water, first of all through the cylinder jackets, and thereafter through a closed system of galvanised pipes which is arranged under a cooling tower.

The other pump takes heated raw water from a basin beneath the cooling tower, and discharges it to a water distributor above this tower, from which it flows over racks of thin timbers placed edgewise in the tower. In this way the water is cooled by the air, and at the bottom of its travel it is diverted to flow over the pipe coils of the cooling system, from which it falls to the concrete collecting basin, to be again taken up by the pump. To provide the small amount of make-up water in the jacket cooling system, the exhaust manifold of each engine is fitted with an evaporating device in which the water supply and water level are controlled automatically. Both the engines and pumps are provided with independent circulating and filtering systems of lubrication.

In pumping the oil, an equalising system is used which minimises the loss by evaporation of the most volatile and valuable components of the crude oil. At each station there is the usual steel storage tank of 37,500 barrels capacity, and a 1000-barrel steel equalising tank, the former being used for emergency purposes. The equalising tank is connected with the incoming line pipe and with the pump suction, so that changes of level of oil in the tank indicate a difference in the amount of incoming and outgoing oil. With these fluctuations of level shown on a gauge, the station operator is able to equalise the pumping. By reason of the comparatively small diameter of the equalising tank, these fluctuations are indicated very quickly.

At each station there are separate buildings for the main line pumping units and for the auxiliary apparatus. They are of brick with concrete floors, and have flat concrete roofs, waterproofed with tarred felt and a layer of gravel. Steel doors and steel window sashes are used to minimise the danger from fire. In the main building there is a 10-ton overhead bridge crane, operated by hand and travelling on runway girders supported by pilasters in the side walls. In the smaller building are the fire and general utility pumps, an electric generator driven by an oil engine, and a small ice-making machine. A tool store and a small repair shop are also to be found in this building.

Neat and attractive five-room cottages are provided for the workpeople, each with running water in the kitchen and bathroom. There is also a garage for the two motor cars and the light truck which form part of the equipment of each station. Sanitary conditions are served by a sewerage system connected to a septic tank.

Pumping through Rifled Pipe.

The difficulties experienced with some of the earlier Californian pipe lines in pumping the heavy and viscid Californian oil led at an early stage to attempts at heating the oil, so that it would be more fluid and would flow more easily. At that time the results were not satisfactory, since at temperatures sufficient for long distance pumping there was a deposit of asphaltine, which caused the pipes to clog. Another method tried was the addition of water, with the idea of forming a film between the oil and the pipe and thus reducing the friction. But as 30 per cent. of water was required to improve the conditions for pumping, and as there was a tendency to form an emulsion which it was difficult and expensive to separate, this plan also failed. Mixing with lighter oils had the objection that these oils had to be pumped for long distances to the heavy-oil fields. Furthermore, the mixing caused a loss of the light oils which commanded a much higher market price than the heavy oils.

To overcome the difficulty, a rifled pipe was designed by Mr. John D. Isaacs, consulting engineer of the Southern Pacific Company, and Mr. Speed, superintendent of pipe lines. By means of a machine specially devised, six helical grooves were cut in each pipe, making a complete turn in 10ft. The idea was that with the centrifugal motion the water would be kept against the pipe, forming a lubricant for the thick stream of oil. The pipe was laid slightly waving in a vertical plane, so as to form traps in which water would collect when pumping was stopped, and thus avoid the formation of solid plugs of oil. At the pumping station the water was introduced into the pipe through an annular opening around the 7in. pipe through which the oil entered the 8in. rifled main. It is of interest to note that the rifling was done by pulling through the pipe a carriage having rollers which indented helical grooves to a depth of about ¼in.

This system of pumping oil through rifled pipes worked very well until such time as, through injudicious drilling of wells, the oil in the fields became saturated with water, and reached the surface in the form of an emulsion. When this fluid was pumped, the water introduced into the pipe to form the exterior film combined with the water in the oil, so that the entire contents of the pipe became emulsified. When emulsification took place, the purpose of the rifled pipe was completely defeated. For the successful transportation of the mass of "wet" oil, it was found necessary to build intermediate pumping stations, and to heat the oil in the usual way in order to make it sufficiently fluid for economical pumping.

Conclusion.

In addition to the great system of trunk lines for pumping oil, practically all the oil pipe companies engaged in transporting petroleum have extensive systems of gathering pipes which bring the oil from the producers' tanks at the oil wells to the tanks of the pumping station at the head of the trunk line. There are also gathering pipe lines which are owned by the producers instead of by the pipe line companies. These gathering systems are composed usually of 4in. and 5in. pipes, carrying relatively light pressure and laid largely on the surface of the ground. The pumping engines are usually of the direct-acting reciprocating type, driven by steam.

Some Alloys of Aluminium.*

By W. ROSENHAIN, S. L. ARCHBUTT, and D. HANSON

Section I.

Introduction.—The present summary gives a brief account of the principal contents of the Eleventh Report to the Alloys Research Committee. That report, comprising 256 pages, 92 figures in the text, and 24 plates, is itself a greatly condensed record of researches covering a period of eight years since the publication of the Tenth Report. Owing to the length of time covered, the effect of war conditions, and other developments leading to the employment of greater resources than those used in connection with earlier reports, the results and data recorded are so numerous that representation by graphs and diagrams has been extensively employed. Here it is only possible to refer briefly to the more important features, but in order to facilitate reference to the full report, page references are given, in brackets, for each item.

In representing the report, the authors point out that the researches are the result of the organised work of practically the whole staff of the Metallurgical Department of the National Physical Laboratory, and that they have received important help from colleagues in other departments of the Laboratory, and from a number of firms and gentlemen connected with the industry. Fully detailed acknowledgments are made (pp. 7 to 10 of the Main Report).

Section II.—Cast Alloys.

II (a). Alloys for Use at Ordinary Temperatures.

In continuation of the researches described in the Tenth Report to the Alloys Research Committee, the properties of the alloys of copper, zinc, and aluminium have been further examined. A considerable number of castings, both sand and chill, have been made and tested. Tensile strengths up to 19 tons per square inch in the case of sand castings and 20 tons per square inch in the case of chill castings have been obtained with alloys containing 2 to 3 per cent. copper and about 25 to 30 per cent. zinc, whereas in alloys containing about 15 per cent. of zinc, tensile strengths of about 14 tons per square inch are recorded (p. 15). For practical purposes, however, the alloys rich in zinc have certain undesirable properties; they are very weak and brittle when hot and are therefore liable to accidental injury in the foundry, and they have a relatively high density. For these reasons, alloys having a rather lower zinc content, in combination with 2 to 3 per cent. copper, have been found most generally useful for castings not exposed to high temperatures. The best known is that which was widely used during the war under the Aircraft Specification "L5." This alloy contains from 12½ to 14½ per cent. of zinc and from 2½ to 3 per cent. of copper. A freshly cast chill test bar is specified to show a tensile strength of not less than 11 tons per square inch and an elongation of 4 per cent. on 2in., requirements which are very moderate, and have often been exceeded by the authors. The strength of such castings, however, increases considerably on ageing (p. 158).

The density of alloys of this system has been determined in a large number of cases (p. 17). In alloys containing up to 3 per cent. of copper the density varies from approximately 2.8 in an alloy containing 5 per cent. of zinc to 3.2 in an alloy containing 25 per cent. of zinc. Castings of "L5" have a density of approximately 3.0, the differences between sand and chill castings being inappreciable.

Other alloys, arising out of investigations described in Sections II (*b*) and II (*c*), are also suitable for use at ordinary temperatures; they are described in the next two sections.

II (b). Cast Alloys for Use at High Temperatures.

The advantages to be gained from the use of aluminium alloys as pistons in aeroplane and other high-duty internal combustion engines having been demonstrated in practical trial as well as indicated by theoretical considerations, the problem of finding the most suitable casting alloy for this purpose became of considerable importance. A very large amount of attention has been devoted to this subject.

In the first place it became necessary to ascertain the strength of various alloys at high temperatures in the manner which has already been described (see Eighth, Ninth, and Tenth Reports to the Alloys Research Committee). The results of tests on aluminium-zinc alloys show that the tensile strength falls off very rapidly as the temperature increases. Further tests at high temperatures have shown that the ternary alloys of copper, zinc and aluminium behave in a similar manner. In the case of the alloy "L5" it is found that, starting with a tensile strength of about 13.5 tons per square inch at normal temperature, the strength falls off at 250 deg. Cent. to little more than 4 tons, and at 350 deg. Cent. to about 1.5 tons per square inch (p. 19). For this reason, alloys containing zinc have been abandoned for use where high temperatures are involved.

The behaviour of certain binary copper-aluminium alloys in the extrusion press had suggested that they possess considerable strength at high temperatures, and an extensive series of tensile tests was therefore undertaken on alloys belonging to this system (p. 21). Alloys containing 6 to 14 per cent. of copper have approximately the same strength (7 tons per square inch) at 250 deg. Cent.; at somewhat higher temperatures, however, the alloys containing 12 to 14 per cent. of copper are distinctly better than those containing lower proportions. The 12 per cent. alloy, for example, at 350 deg. Cent. possesses a tensile strength of about 4.6 tons per square inch as compared with 3.4 tons per square inch for the 8 per cent. alloy. The alloy containing 12 per cent. of copper has been extensively used for the manufacture of light alloy pistons and is well known by its Air Board specification number "L8."

Efforts were made to improve the properties of the simple copper-aluminium alloys by the addition of other elements, and it was found that manganese in small proportions has a profound influence on their strength. In alloys containing both 8 and 14 per cent. copper, both chill and sand cast, it was found that the addition of 1 per

* Institution of Mechanical Engineers: Official Summary of the Eleventh Report to the Alloys Research Committee.

cent. of manganese causes an actual increase in tensile strength with rising temperature up to 250 deg. Cent.; at this point the tensile strength is approximately 1 ton per square inch greater than at normal temperatures. Above 250 deg. Cent. the strength decreases at much the same rate as that of the pure copper alloys; but, owing to the initial rise, the strength at 350 deg. Cent. is still very much better. In the 14 per cent. copper alloy containing 1 per cent. manganese the strength rises from 9 tons, as chill cast, to 10 tons per square inch, when tested at 250 deg. Cent., while at 350 deg. Cent. 6.4 tons per square inch are still obtained. In the case of sand castings the results at normal temperatures and at 250 deg. Cent. are approximately 1 ton per square inch less than chill castings, but at 350 deg. Cent. this difference has practically disappeared (p. 23).

This effect of manganese was so striking that it was investigated more closely, with a view to ascertaining if the addition of greater or smaller amounts would produce better results. It was, however, found that the best results were obtained with 1 per cent. manganese, and that the effect of this element was less if the content differed appreciably from this value (p. 24).

For various reasons (p. 24) the 14 copper, 1 manganese alloy was not regarded as the final solution of the piston alloy problem, and other alloys were investigated. Additions of iron, molybdenum, tungsten, chromium, vanadium and other elements to copper-aluminium alloys were tried without better results. In the majority of these alloys it was found that a comparatively small addition of the second element made the metal very difficult to cast. More promising results were obtained in the case of nickel-copper-aluminium alloys, which were at a later date further improved by the addition of small amounts of magnesium. The first result of adding nickel is a marked increase in the tensile strength, both in the cold and at 250 deg. Cent. (p. 27). For example, the strength of the 12 per cent. copper alloy at normal temperature is raised by nearly 2 tons by the addition of 3 per cent. nickel, and by over 3 tons per square inch at a temperature of 250 deg. Cent., at which a tensile strength of 10 tons per square inch is obtained. At 350 deg. Cent., however, the tensile strength is still rather low, namely, 5.3 tons, about 1 ton per square inch lower than that of the "14/1" alloy. The addition of small amounts of magnesium to alloys containing both copper and nickel led to further improvement (p. 28). In one case, in an alloy containing 8 per cent. copper, 2 per cent. nickel, and 1 per cent. magnesium, a tensile strength of nearly 13 tons was observed, as compared with 8 tons per square inch in the alloy having the same copper and nickel content without magnesium. Ultimately it was found that the copper content of these alloys could be safely reduced with considerable advantage both to lightness and to thermal conductivity, and an alloy containing 4 per cent. copper, 2 per cent. nickel, and 1½ per cent. magnesium, mentioned elsewhere in this report as alloy "Y," was adopted. This alloy, in the form of 1in. chill castings, possesses a tensile strength of 13 tons per square inch, at normal temperature, which only falls to a little over 11 tons per square inch at 250 deg. Cent., to 8 tons per square inch at 300 deg. Cent., and to 5 tons per square inch at 350 deg. Cent. An interesting and important observation in connection with this alloy is that the elongation at 350 deg. Cent. is fairly large (about 15 per cent.); this led the authors to try forging and rolling of the material with very successful results (Section III (c).

Further experiments showed that the nickel and magnesium contents of this alloy might be varied within reasonable limits without very harmful effects, but the composition originally arrived at, as quoted above, is the best of the materials tested.

Casting of the Alloys.

In addition to the ordinary precautions which have to be taken in making complicated castings, in order to avoid such defects as "drawing," evolution of gas, &c., some special points may be mentioned. In the case of alloy "Y" and other aluminium alloys containing magnesium, the method of adding this latter element is found to be of importance. In the authors' experience it has been found best to add the magnesium in the form of pure metal cut into fairly large pieces and to push these rapidly under the surface of the molten aluminium, so that they can dissolve without coming into contact with the air. The addition should be made immediately before the metal is poured into the mould. Some care is also necessary in making additions of nickel. Pure nickel does not readily dissolve in aluminium, and the authors find it best to prepare a "hardener" or rich alloy, containing 20 per cent. of nickel, and to add this in the requisite quantity to molten aluminium. Hardeners richer in nickel are to be avoided on account of their high melting points (p. 32).

Thermal Conductivity.

The gain in efficiency in internal combustion engines which results from the use of light alloy pistons is due, not so much to any small saving in weight of the reciprocating parts, as to the greater heat-conducting power of the aluminium alloy. Careful determinations of the thermal conductivities of the different alloys were therefore made during the progress of the research (p. 37). The values obtained for the various alloys do not, as a rule, differ to any large extent, although the "14/1" alloy, in the "as cast" condition, is a notable exception to this rule. In this latter case values of 0.25 to 0.27 were found in castings tested at 100 deg. Cent., as compared with values of 0.35 to 0.39 in the case of most of the other alloys, and with 0.50 in the case of pure aluminium. The values found for alloy "Y" are appreciably higher, 0.37 and 0.40 being obtained in the case of chill castings tested at 100 deg. Cent. and 300 deg. Cent. respectively. Annealing at 450 deg. Cent. has a beneficial effect on practically all the alloys, this effect being slight except in the case of the "14/1" alloy, which, after this treatment, is little inferior to any of the others. Comparison tests made on samples of cast iron gave values of 0.10 to 0.12 under similar conditions of heat treatment and testing.

II (c). Heat Treatment of Castings.

Considerable improvement in the mechanical properties of cast aluminium alloys has been obtained by suitable heat treatment. Practically all castings possess inequalities of composition due to micro-segregation during solidification. In the case of the simple copper-aluminium alloys,

Table 1.—*Alloy "Y." 1in. Diameter Chills.*

Treatment.	Ultimate stress. Tons per square inch. 15 deg. C.	250 deg. C.
As cast	12.6	10.5
Tempered 48 hours at 250 deg. C.	9.8	8.6
Heat Treated.		
(1) Open muffle :—		
6 hours, 480 deg. C., quenched and aged	14.9	11.3
6 hours, 480 deg. C., tempered 48 hours at 250 deg. C.	13.4	10.1
48 hours, 480 deg. C., quenched and aged	15.8	12.0
48 hours, 480 deg. C., tempered 48 hours at 250 deg. C.	13.8	9.4†
(2) Nitrate bath :—		
6 hours, 480 deg. C., quenched and aged	14.6	12.8
6 hours, 480 deg. C., tempered 48 hours at 250 deg. C.	13.2	11.0
48 hours, 480 deg. C., quenched and aged	16.0*	13.7
48 hours, 480 deg. C., tempered 48 hours at 250 deg. C.	16.0	12.0
(3) Nitrate bath :—		
6 hours, 530 deg. C., quenched in boiling water and aged	21.0‡	—

* Maximum elongation at 15 deg. C. at 2.25 per cent. on 2in.
† Maximum elongation at 250 deg. C. at 3.75 per cent. on 2in.
‡ Elongation at 15 deg. C., 6 deg. 5 per cent.

for example, castings containing as little as ½ per cent. of copper normally contain free particles of the compound $CuAl_2$, whereas a saturated solid solution of this compound in aluminium contains nearly 5 per cent. of copper. By annealing at about 500 deg. Cent. the undissolved $CuAl_2$ can be brought into solid solution in alloys containing up to about 4½ per cent. of copper, with considerable improvement in the mechanical properties; for example, the strength of the alloy containing 2 per cent. copper was found to increase from 8 tons per square inch "as cast" to 10 tons per square inch after annealing, and that of the alloy containing 4½ per cent. of copper from 9½ tons to 15 tons per square inch. At the same time a remarkable increase in elongation is produced (p. 40).

Still more striking and important results have been obtained by heat treatment applied to castings of the alloy "Y." In the first place, prolonged annealing at a temperature near 500 deg. Cent. was applied, and this was followed by quenching and ageing, either at room temperature or at higher temperatures up to 250 deg. Cent. (p. 41). Some of the results obtained after various treatments of castings of this alloy are shown in Table I. (Table IV., p. 42 of the Main Report).

Attention is drawn to the high value obtained after heat treatment at 530 deg. Cent., followed by quenching in boiling water, and ageing.

Section III.—Wrought Alloys.

This section deals with alloys capable of being wrought by such operations as forging, rolling, extrusion, cold working, &c., and describes not only the mechanical properties of the alloys when heat-treated, but also their behaviour while undergoing working and the methods adopted in order successfully to produce them on a manufacturing scale.

III (a). The Ternary Alloys of Aluminium, Zinc, and Copper.

A study of the behaviour and properties of the ternary alloys of copper and zinc with aluminium naturally followed the results of the Tenth Report to the Alloys Research Committee. The results of this study led at once to a further examination of the alloys containing 3 per cent. of copper with 20 and 25 per cent. of zinc, which were mentioned in the previous report. Preliminary experiments carried out at the works of the British Aluminium Company convinced the authors that successful rolling of these alloys could be achieved. As soon as the experimental rolling mill was installed at the National Physical Laboratory a systematic study of these alloys was commenced. In the case of the "3/25" alloy (alloy B) considerable initial difficulties were experienced, and, in view of the urgent need for the production of a satisfactory light alloy, attention was transferred to the distinctly softer alloy, containing 3 per cent. copper and 20 per cent. of zinc (alloy A), whose properties are little inferior to those of alloy B, and which has the advantage of a slightly lower density.

A complete study was made of the different factors which influence casting, forging, and rolling, and the treatment necessary for success at all stages was carefully determined. Particular attention is drawn to the necessity for obtaining a casting free from surface defects and shrinkage cavities, and the necessary methods are described (p. 74). Suitable regulation of the forging temperature and the amount of forging, as well as adequate lubrication of the rolls, were also found to be essential (p. 75). By the suitable regulation of these and other conditions, billets were successfully broken down and rolled into bars 1¼in. or 1½in. diameter, after which no further difficulty was experienced in reducing the alloy to any desired size. Certain new difficulties arose in connection with the production of sheet, especially when cast slabs of large size were used, and it became necessary further to study the casting conditions before the initial difficulties were overcome. The fact that the condition of the surface was largely responsible for cracking, which occurred during breaking down, was shown by results obtained in forging and rolling slabs whose cast surface had been removed in a planing machine to a depth of approximately ½in. After forging, these machined slabs gave practically perfect rolled blanks. By the use of various mechanical aids, of which the most successful was a small V-shaped groove, cut from top to bottom at one side of the slab mould, down which the metal was poured, satisfactory surfaces were obtained. After removing the small V-shaped runner on the edge of the slab it was found possible to obtain forged and rolled blanks practically free from defects. Another difficulty in the early stages was low ductility in the transverse direction, which was overcome by cross rolling with excellent results (p. 77).

III (b). Cold Working.

In connection with the production of very thin sheet and of spinnings of alloy "A," it was necessary to study the conditions under which this material can be cold-worked. At first considerable difficulties were encountered through loss of ductility of the material, which was not restored by the annealing process adopted. An investigation into the annealing properties of the alloy (p. 81) showed that too high a temperature was being used (450 deg. Cent.), and by the adoption of a much lower temperature (250 deg. Cent.) successful results were obtained. It should be noted, however, that although material which has been cold-rolled and annealed at 250 deg. Cent. possesses considerable ductility, it is somewhat weaker than the same material in the "as rolled" condition, a difference of 3 to 4 tons per square inch being found. By the use of the treatment outlined above, not only were successful spinnings of this material obtained, but it was also found possible to produce very thin sheet (0.0035in. thick), having a tensile strength of 23 tons per square inch. With a more suitable set of rolls it is probable that this thickness could be reduced still further (p. 84).

In the same way, no difficulty was found in the production from rolled rod of wire of any desired diameter, by cold-drawing with intermediate low-temperature annealing; wire of 0.0125in. diameter was successfully produced by Messrs. Wiggins, of Birmingham, from ½in. rod rolled at the National Physical Laboratory. In the "as drawn" condition this wire possesses a tensile strength of 27 tons, and, after annealing at 250 deg. Cent., a strength of 20.7 tons per square inch. A summary of tensile tests on this alloy in various conditions is given in Table 2 (Table 39, p. 143 of the Main Report).

The data there given represent mean values derived in many cases from a large number of tests, and the authors consider that these values can readily be obtained in ordinary manufacture. The data referring to elastic limit represent the "limit of proportionality," as measured by means of a delicate extensometer. Results of further tests are given in the Main Report and include shear tests (on sheet), in which values of 22 to 23 tons per square inch have been found (p. 92), fatigue tests (p. 93), some results of which are given in Table 5 of this summary.

Table 2.—*Summary Table. Tensile Tests. Alloy "3/20." Density 3.1.*

Material.	Condition.	Elastic limit. *	Limiting proof stress. *	Yield stress. *	Ultimate stress. *	Reduction of area, per cent.	Elongation per cent. on 2in.
Rod.							
1in. diameter	(1) Hot rolled	11.8–13.0		17.6	26.4	29.8	17
1½in. diameter	Hot rolled	—		18.5	27.4	—	18
¾in. diameter	Hot rolled	—		18.3	27.0	36.0	21
¾in. diameter	Hot rolled	—		17.4	26.7	—	30†
1½in. diameter	(2) Annealed 200 deg. C.	—		15.1	24.8	—	21
¾in. diameter	Annealed 225–250 deg. C.	9.1		—	26.1	21.4	19
Sheet.							
0.104-0.048in. thick	(1) Hot rolled	—	18–21	16.9	27.2	—	19
0.020in. thick	Hot rolled	—	—	—	25.2	—	13–17
0.050in. thick	Hot rolled, aged four years	—	—	27.0	33.0	—	16
0.104in. thick	(2) Do., annealed 200 deg. C.	—	—	12.3	22.2	—	24–28
0.119-0.048in. thick	(3) Cold rolled	—	—	26.0	29.7	—	11
	(4) Do., annealed 225–250 deg. C.	—	—	13.0	24.0	—	20
Wire.	Produced from ½in. rod by cold drawing with intermediate low temperature annealing.						
0.063in. diameter	(1) As received from Messrs. Wiggins	—	—	—	27.8	—	8†
0.020in. diameter	—	—	—	—	31.0	—	5‡
0.0125in. diameter	—	—	—	—	27.3	—	2‡
0.063in. diameter	(2) Annealed 250 deg. C.	—	—	—	20.7	—	14‡
0.020in. diameter	—	—	—	—	22.3	—	9.5‡
0.0125in. diameter	—	—	—	—	20.7	—	—

* All in tons per square inch. † On 1in. ‡ On 4in.

notched bar impact tests (p. 93), and low temperature tensile tests, carried out at temperatures of − 80 deg. Cent. and − 185 deg. Cent., which showed that such intense cold had no embrittling action (p. 98).

III (c). Development of Alloys "E" and "Y."

Numerous attempts have been made throughout the course of this research to improve the mechanical properties of the alloys by making use of the hardening effect produced by the addition of small quantities of magnesium. Since the aluminium-zinc-copper alloys, whose development has already been described, have such good tensile properties, it was hoped that the application of the hardening effect due to magnesium would bring about a

considerable further advance. The addition of magnesium immediately introduced further difficulties, and especially increased the difficulty of forging. Attention was therefore turned at this stage to the possibility of bringing these alloys into workable condition by use of the extrusion process (see Summary, p. 18), and a number of alloys were more or less successfully broken down in this manner and rendered suitable for hot rolling. Of the alloys examined in this way, one in particular, having the following nominal composition :—

	Per cent.
Copper	2.5
Zinc	20.0
Magnesium	0.5
Manganese	0.5
Iron, not exceeding	0.2
Silicon, not exceeding	0.2

was successfully extruded and rolled. After heat treatment, which consisted in quenching at 350 deg. Cent., followed by ageing at room temperature, it was found to possess a primitive elastic limit of about 20 tons, a yield stress of over 32 tons, and an ultimate stress of about 37 tons per square inch, together with an elongation of 11 to 12 per cent. on 2in. By quenching from 400 deg. Cent. tensile strengths as high as 40 tons per square inch have been obtained. The above results constitute a considerable advance on any light alloy previously produced, so far as tensile properties are concerned, and special attention was therefore devoted to the further development of alloys of this type. For various reasons it was considered desirable, if possible, to develop methods of breaking down the alloy which did not involve the use of extrusion. Experience gained in the production of alloy "A" suggested that the difficulties met with in forging these harder alloys might result from defects in the castings, and special attention was therefore given to this operation. The earlier difficulties were found to be due mainly to the method of adding magnesium, which had been introduced in the form of a magnesium-aluminium alloy containing 20 per cent. of the former metal. Slabs produced in this way, when examined under the microscope, were found to possess serious defects, such as inclusions of oxide and unsoundness; by adding magnesium in the form of pure metal just before casting, in the manner already indicated (see Main Report, p. 106), sound slabs were produced which gave much better results on working. In spite of this improvement and of many variations in the methods of forging, edge cracking during breaking down has never been completely eliminated. Once the material has been reduced 50 per cent. in thickness, however, and has been trimmed to remove cracked and defective portions, little further trouble with cracking is experienced. Subsequent to the successful production of this alloy, known as alloy "E," at the National Physical Laboratory, its manufacture on an industrial scale was studied and developed at the Royal Airship Works at Cardington, at that time under Messrs. Short Bros. There the treatment was modified by machining the surface of the slabs, annealing them before forging, and using a heavier hammer and more drastic forging treatment. By these means the amount of scrap was considerably reduced, and in addition, it was found that the more drastic forging treatment produced an improvement in the ductility of the product.

Alloys "F" and "G."

In order to obtain a somewhat softer alloy two modifications of composition, suggested by the authors, were tried at Cardington. The first of these, known as alloy "F," consists in the addition of a small amount of silicon to bring the total silicon in the alloy up to approximately 0.75 per cent. This makes the alloy slightly softer and reduces the average tensile strength to 35 tons, as compared with 39 tons per square inch of the alloy "E;" the elongation is increased to 18 per cent., as compared with 15 per cent. of alloy "E." A further modification, leading to the alloy known as "G," was made by reducing the percentage of the added elements, zinc, manganese and magnesium. The composition is as follows :—

	Per cent.
Copper	2.5
Zinc	18.0
Magnesium	0.35
Manganese	0.35
Silicon	0.8
Aluminium	Remainder

This change in composition reduces the tensile strength very little as compared with alloy "F," but a considerable increase in elongation is obtained.

A summary of the tensile properties of alloys "E," "F" and "G" is given in Table 3 (Table 40, p. 144 of Main Report).

These alloys, when suitably treated, give a wide range of properties, tensile strengths up to 40.7 tons per square inch being available. This latter figure is given by a treatment consisting in quenching at 400 deg. Cent., followed by ageing, and, as will be seen later, produces an alloy which is liable to fail somewhat readily by "season cracking." Quenching from a lower and perfectly safe temperature, such as 350 deg. Cent., gives an alloy with an ultimate stress of approximately 38 tons per square inch with a correspondingly greater elongation.

Alloy "Y."

Reference has already been made in the section on "casting alloys for use at high temperatures" to certain alloys containing copper, nickel and magnesium, which not only possess a considerable degree of strength at high temperatures, but have remarkable ductility in the range of temperature which is usually employed for the rolling of aluminium alloys. Alloys of the type "A," "E," "F," and "G" are subject to certain limitations, since they lose their strength very rapidly with increase of temperature, are particularly susceptible to certain types of corrosion—see below, IV (*d*)—and, after certain conditions of heat treatment, they are liable to failure by "season cracking." It therefore became desirable to look in other directions for alloys which, while possessing a reasonable degree of strength, should be as free as possible from these limitations. For this reason alloys of the "Y" type, containing copper, nickel and magnesium, have been developed. A large number of exploratory alloys containing various proportions of copper, nickel and magnesium have been made and tested, and as a result of this preliminary work attention has been concentrated on the alloy already referred to as alloy "Y," which gives the best results at ordinary and at high temperatures. With regard to forging and rolling, no particular difficulties were encountered, beyond a little edge cracking during the production of sheet. It was, however, found desirable to use higher forging and rolling temperatures than those which are suitable for alloys containing zinc. Some difficulty was at first experienced in obtaining tensile strengths appreciably greater than 22 tons per square inch in rolled material quenched from 480 deg. Cent. and aged. At a later date, however, considerable improvement resulted from the use of a higher quenching temperature, namely, 520 deg. Cent., and the use of boiling water as a quenching medium. Tensile strengths of 24 tons per square inch, together with an elongation of 10 per cent. have been obtained. In the case of thin sheet tensile strengths up to 28 tons per square inch, together with an elongation of 17 per cent., have been obtained by cold rolling followed by quenching at 530 deg. Cent. and ageing. The tensile properties of alloy "Y" are summarised in Table 4 (Table 41, p. 146 of Main Report).

Table 4.—*Summary Table. Tensile Tests. Alloy "Y." Density 2.80.*

Material.	Condition.	Elastic limit. *	Limiting proof stress. *	Yield stress. *	Ultimate stress. *	Reduction of area, per cent.	Elongation per cent. on 2in.
Rod.							
½in. diameter	Hot rolled	—	—	12.0	17.6	30.0	20.0
½in. diameter	Quenched 530 deg. C. and aged	7.7	—	15.4	24.1	33.0	23.0
½in. diameter	Cold rolled from 1¼in. diameter, hot rolled, quenched 530 deg. C. and aged	7.7	—	15.2	24.2	34.0	25.0
½in. diameter	Cold rolled from ¾in. diameter, hot rolled, quenched 520 deg. C. and aged	—	—	14.8	22.9	31.0	26.0
Sheet.							
0.05in.	Hot rolled, quenched 480 deg. C., aged	—	12.6–14.9	16.2	23.2	—	19.0
0.05in.	Hot rolled, quenched 530 deg. C., aged	—	—	17.2	26.0	—	19.0
0.05in.	Cold rolled, quenched 530 deg. C., aged	9.8	17.5	20.8	26.9	—	17.0
0.018in.	Cold rolled, quenched 530 deg. C., aged	—	19.0	21.0	28.0 (1)	—	17.0

* All in tons per square inch.

General Comparisons of Alloys "A," "E," "F," "G," and "Y."

Although the tensile properties of these alloys are given in Tables 2, 3, and 4 in a manner which renders comparison simple, there are many other properties which are of great importance in connection with their practical application. In particular, the fatigue range, both at ordinary and slightly elevated temperatures, is of importance in view of the possible use of these alloys for the working parts of machinery, such as connecting-rods of aeroplane or automobile engines. The safe range of alternating stress which the material might, as the result of the Wöhler test, be expected to endure indefinitely is shown in Table 5 (Table 45, p. 150 of Main Report), which also includes tests on certain modifications of these alloys. Alloy "Y1" corresponds in composition with the normal alloy "Y," but with the addition of ½ per cent. of manganese. Alloy "Y2" contains both ½ per cent. of manganese and 0.75 per cent. of silicon. Alloys "D1," "D2," and "D3" are of the "Duralumin" type and contain 3 per cent., 5 per cent., and 6 per cent. of copper respectively. Alloy "M" contains 2 per cent. of copper, 1.5 per cent. of nickel, and 1 per cent. of magnesium, with the usual impurities, and corresponds very closely to the alloy known as "Magnalite." Alloy "R" contains 0.1 per cent. of magnesium and the normal impurities. A general comparison of the data given shows that, particularly at somewhat elevated temperatures, the alloy "Y" is superior to any of the others. A remarkable and somewhat disappointing result is given by the alloy "E," whose fatigue range is considerably lower than might be expected from its tensile properties. Alloy "Y," although slightly weaker than the others at ordinary temperature, is of special value because it is distinctly superior, both as regards tensile strength and resistance to all alternating stresses at elevated temperatures, while it also combines with these properties immunity from "season cracking," and a very remarkable resistance to corrosion. It is certainly not more difficult to produce under manufacturing conditions than alloy "A," and in this respect it is distinctly superior to the alloys "E," "F," and "G." Its specific tenacity is approximately equal to those of alloy "A" and "Duralumin."

Table 5.—*Fatigue Tests (Wöhler Method) on Wrought Alloys.*

Material.	Safe range of alternating stresses.	
	20 deg. C.	110 deg. C.
Hot-rolled rod, ½in. diameter	± 20.0	± 11.0
Alloy A (3/20)	± 8.7	± 4.5
Alloy B (3/25)	± 10.5	—
Alloy E*	± 9.7	± 5.1
Alloy Y*	± 10.2	± 8.4
Alloy Y1*	± 10.3	± 8.2
Alloy Y2*	± 9.0	± 6.5
Alloy D1*	± 10.5	± 7.2
Alloy D2*	± 10.5	± 7.9
Alloy D3*	± 10.2	± 5.0
Alloy M	± 9.0	± 7.0
Alloy R	± 6.5	± 5.5

* Heat-treated and aged.

III (d). Extrusion.

In order to overcome certain difficulties in breaking down many of the high-tensile alloys described in the report, experiments on extrusion were undertaken in co-operation with the British Aluminium Company and the Muntz Metal Company. Earlier experiments showed that many alloys could be treated by this process, and that such material could readily be rolled to smaller sections. Much of the extruded material contained longitudinal defects, which caused laminated fracture when bars are notched and broken by a blow. Experiments carried out with soft plastic substances made of different coloured layers and extruded from small model cylinders gave interesting results which led to useful modifications in the extrusion process. It was found that the longitudinal central defect, which causes lamination, is due to the drawing down into the bar of ingot defects, particularly the central pipe, or of portions of the skin, particularly from the back of the original ingot. The authors therefore used ingots which were cast in such a manner as to avoid the formation of any considerable contraction cavity. The evil effect of such a cavity can be still further reduced by placing the top end of the ingot towards the die in the extrusion press. Drawing down of the rear surface of the ingot was prevented by placing between the ram and the billet a steel friction plate provided with corrugations (p. 129).

With regard to mechanical tests, the tensile properties of extruded material of satisfactory quality are usually similar to those of the same alloy manufactured by forging and rolling. In a few cases, however, somewhat inferior results have been obtained.

(To be continued.)

Table 3.—*Summary Table. Tensile Tests. Alloys "E," "F," and "G." Density 3.1.*

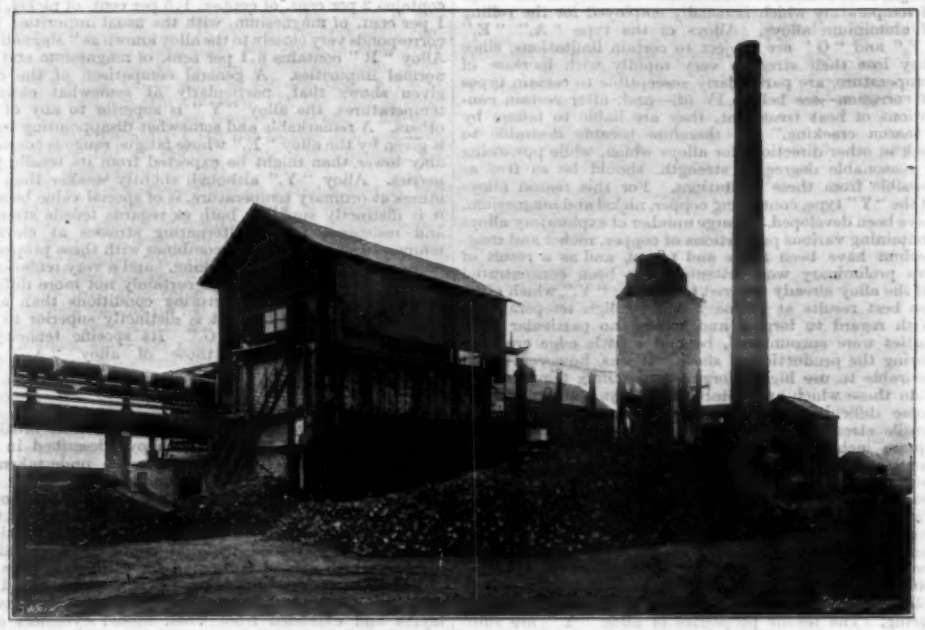
Material.	Condition.	Elastic limit. *	Limiting proof stress. *	Yield stress. *	Ultimate stress. *	Reduction of area, per cent.	Elongation per cent. on 2in.
Rod.							
"E" ½in. diameter	(1) Hot rolled	—	—	23.7	29.7	—	15
"E" ½in. diameter	(2) Quenched 350 deg. C., aged 1½ hours	—	—	16.8	29.7	—	20
"E" ½in. diameter	Quenched 350 deg. C., aged 5 days	22.1	—	32.9	37.8	13.4	12
"E" ½in. diameter	Quenched 400 deg. C., aged 5 days	—	—	21.6	40.7	—	9
"F" ½in. diameter	Quenched 400 deg. C., aged	—	—	25.3	36.6	21.4	16
Sheet.							
"E" 0.04–0.05in.	(1) Hot rolled	—	—	24.5	32.4	—	18
"E" 0.04–0.05in.	(2) Quenched 400 deg. C., aged	—	28–31	29.3	38.2	—	15
"E" 0.04–0.05in.	(3) Hot rolled annealed 250 deg. C.	—	—	14.5	25.3	—	20
"F" 0.04–0.05in.	Quenched 400 deg. C., aged	—	25–28	30.4	35.4	—	19
"G" 0.04–0.05in.	Quenched 400 deg. C., aged	—	24–25	30.6	34.6	—	19

* All in tons per square inch.

NEW STEAMSHIP SERVICE TO AUSTRALIA.

A new series of big fast vessels has been specially built for the Commonwealth Government Line. They have large passenger and cargo capacity, and by omitting Mediterranean ports will, it is said, accomplish the voyage in at least three or four days less time than any other line to Australia, including mail service lines, a voyage of thirty days from London to Fremantle being anticipated. Five new steamers, each of a register of about 14,000 tons, have been built. Each bears the name of an Australian coastal bay—Moreton Bay, Largs Bay, Hobsons Bay, Jervis Bay, and Esperance Bay—being thus representative of the five largest States of the Commonwealth. They are built to uniform design and are fitted with up-to-date appliances to ensure rapid and safe handling of cargo, of which, owing to size of hatches, nature of gear, &c., all classes can be carried. Special facilities and compartments are provided for the stowage of special cargo. Only a small number of first saloon passengers will be carried, the bulk of the room being available for third class to a total of over 700, in two, four, and six-berth cabins. The Moreton Bay, the pioneer of the new line, is timed to leave London on December 7th, and the other ships of the "Bay" class will follow her at four-weekly intervals. They will proceed direct from London to Port Said, thence to Colombo and Australia, calling in turn at Fremantle, Adelaide, Melbourne, Sydney, and Brisbane, the terminal port. This new service of Australian steamers is in addition to the existing large cargo fleet, which will be continued as heretofore.

SMOKELESS FUEL PLANT AT BARUGH



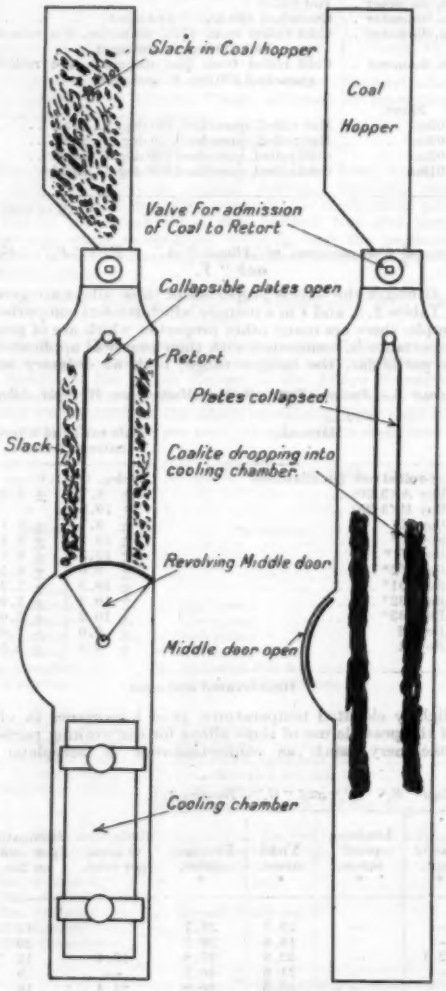
The Low Temperature Carbonisation of Coal.

More than twenty years ago the late Mr. Thomas Parker, the well-known electrical engineer, took the first really serious step towards the production of a smokeless fuel called "Coalite" by the treatment of coal at low temperatures, and although he succeeded in some measure, the process, for various reasons, never proved a commercial success, largely because the means of manufacturing on a large scale were not satisfactory. The chief difficulty lay in the construction of the retort. Both iron and brick retorts were tried, but in each case the temperatures produced were too high. Another obstacle has all along been the difficulty of discharging the resultant hot fuel from the oven so as to prevent it firing on coming into contact with the atmosphere, for the low temperature process, of course, necessarily leaves in the final product a considerable amount of volatile matter which must not be burnt off. Recently, however, another stage has been reached in the development of the process of manufacture by which the earlier difficulties have been, to a large extent at any rate, surmounted.

The chief improvement lies in the design of the retorts, which we had an opportunity of inspecting a few days ago at the works of Low Temperature Construction, Limited, at Barugh, near Barnsley. The inventor of the new retort is Mr. T. M. Davidson, who claims to have got over the difficulty of the cast iron retort by using for the purpose a special mixture of iron rich in manganese. The apparatus consists of three essential parts: first, a hopper in which the coal for treatment in the retort is collected; secondly, a rectangular oven, between which and the hopper a rotary door is provided to allow the coal to fall gently into the oven at pre-arranged periods of time; thirdly, another rectangular gas-tight chamber below the oven, into which the carbonised coal is discharged by means of a second rotary door and from which it can be removed by means of end doors when sufficiently cool. Lengthwise of the oven are suspended two vertical perforated cast iron plates, 7ft. 6in. in length by 8ft. 6in. high, which are normally kept at a certain distance apart, but can be brought together by means of a hinged rocker to allow the carbonised material to drop gradually into the cooling chamber. Coal in the form of slack is filled into the spaces—about 4in. wide—between the plates and the oven walls, the intervening space between the plates being clear for the escape of the gases. The ovens are heated by means of gas flames, which are caused to pass backwards and forwards along the walls of the oven and transmit their heat to the fuel, while the gases of combustion are drawn off through the centre plates, which also serve to keep the coal compact.

The process of carbonisation is said to take between seven and eight hours, and when it is complete the rotary door between the oven and the cooling chamber is moved into a recess, allowing the cakes of "Coalite" to slide down into the chambers, which are cooled by means of a jacket through which water is caused to circulate. The burner flues are horizontally situated one above the other between the retorts, the spent gases passing downwards at the end of each horizontal passage into a similar flue below, being regenerated at each downward passage by means of supplementary burners until they reach the bottom of the oven, when they enter recuperators on either side of the battery, where they pass upwards and downwards in the opposite direction to the primary air supply, which is thereby pre-heated. Finally, the spent gases pass downwards between the water jackets to the main flue. The air and gas are supplied to the battery of ovens at either side and there seems to be very little heat wasted through the battery walls.

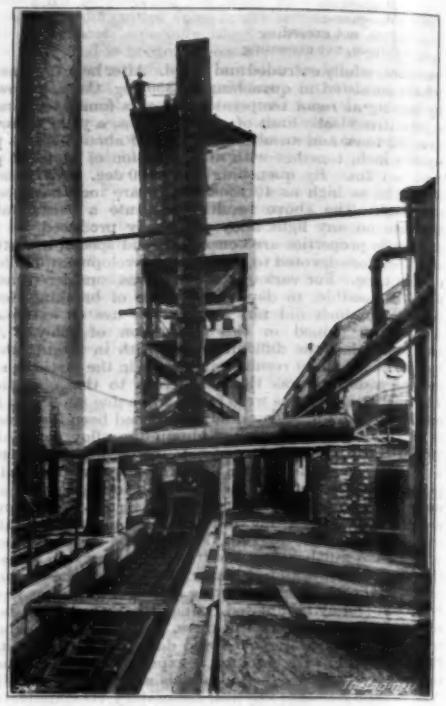
For low temperature carbonisation it is of the utmost importance that there should be no leakage of rich gas from the retorts to the burner flues, otherwise the temperature would be too high, and in the retorts under review it is claimed that this is prevented by means of exhausters which take off the rich gases at the coolest side of the fuel, viz., the inside, through and between the perforated collapsible plates—an arrangement which prevents the gases coming into contact with the incandescent coke, thus preventing cracking of the gas as well as loss of heat. In this respect the process seems to be effective in the Barugh plant, the temperature of the gas given off being between 70 deg. and 80 deg. Cent. In all there are twenty



DIAGRAMMATIC SECTIONS OF RETORT

ovens at work, each capable of dealing with charges of 15 cwt.; but at the time of our visit 12-cwt. charges were being used, and the output is said to be 110 tons of coke per week. The temperature at which the retorts are operated is about 550 deg. Cent. The fuel used comprises a mixture of Claycross non-coking slack, 70 per cent., and Parkgate coking slack, 30 per cent. The former, before washing, contains some 14 or 15 per cent. of ash and the latter some 8 or 9 per cent. The final analyses are as follows:—Claycross: Volatile matter, 36.4 per cent.; ash, 5.2 per cent.; fixed carbon, 58.4 per cent. Parkgate: Volatile matter, 34.0 per cent.; ash, 4.9 per cent.; fixed carbon, 61.1 per cent. The resultant coke analysis is given as:—Fixed carbon, 86.6 per cent.; volatile matter, 10 per cent.

From each ton of slack the company states that 14 cwt. of smokeless fuel, 16 gals. to 18 gals. of tar oil, 6000 cubic feet of gas of a calorific value of 700 B.Th.U per cubic foot, 14 lb. of sulphate of ammonia, and from 2 to 3 gals. motor spirit are produced. The coke or "Coalite" is of a homogeneous nature—about one-half the weight of coal—and the amount of breeze is said to be about 4 per cent. From



COAL ELEVATOR

an inspection of the coke we should be inclined to doubt whether the entire products of the battery are being equally carbonised, for some of the pieces we came across appeared to contain a percentage of more or less green coal which would certainly not be free from smoke.

The success or otherwise of the process depends almost entirely upon the operation of the retorts, which are of ingenious conception, and a decided advance upon anything of the kind hitherto invented; but the design leaves the impression that there is still room for further improvement, which will probably be evolved by greater experience on a commercial scale.

DIESEL ENGINE USERS' ASSOCIATION.

In a paper by Mr. Geoffrey Porter on "The Function of the Heavy Oil Engine in Connection with the General Supply of Electricity," read at a meeting of the Diesel Engine Users' Association held at the Institution of Electrical Engineers on October 13th, the author submitted interesting figures of working costs, including capital charges, of undertakings using steam plant or heavy oil engines or a combination of both, and in each case he showed the permissible purchase price for a bulk supply from an outside source. Curves showing total transmission losses of various mean loads and power factors, permissible purchase prices, costs per unit of alternative methods of operating, &c., accompanied the paper. There were also appendices giving particulars of Diesel engine performances of actual undertakings, heavy fuel oil engine consumptions, examples of terms offered to local supply authorities for bulk supply, and estimated cost of a power station employing heavy oil engines.

In the discussion on the paper there was, naturally, considerable difference of opinion with regard to the merits or demerits of various systems of providing for a supply of electricity in an area under varying conditions; but it was generally admitted that there could be no case for complete bulk supply—that is, for a system of supplying in bulk throughout the country—which would entirely eliminate local generating stations of comparatively small power, and that there was a very strong case for the installation of heavy oil engine plant so long as a good supply of suitable liquid fuel could be ensured. One speaker who had experience in connection with about forty electricity supply undertakings equipped with Diesel engines, gas engines, steam engines, and steam turbines, and some of which were taking bulk supplies, referred to the very large number of cases in which no bulk supply could compete with the local generating station. Yet he felt that bulk supply should be made use of wherever possible, and even perhaps in certain cases in which at the moment it might not be the most economical, but that every case must be considered on its own merits. He added that he had no doubt that the Electricity Commissioners would be found to be approachable and willing to hear all sides of any question of this sort, and he felt certain that after the experience which the Commissioners had obtained during the past year, they would now understand the many difficulties and limitations of bulk supply, and that anyone with a good case for local extensions of generating plant would get a fair hearing.

A New Method of Making Concrete Roads.

A new method of making concrete roads has been devised and patented by Mr. J. H. Walker, an engineer with the Port of London Authority, and is being exploited by the Walker-Weston Company, of 7, Wormwood-street, London, E.C. 2. Among the chief reasons which led Mr. Walker to devise the method, which is described in what follows, were first, that concrete, in setting, contracts ¼in., or more, in every 100ft. of length, and, in addition,

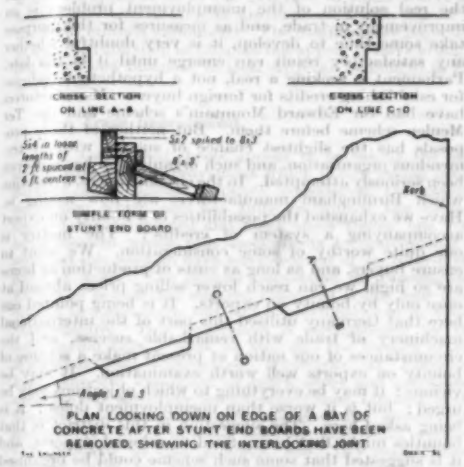

CROSS SECTION ON LINE A-B
CROSS SECTION ON LINE C-D
3x4 in loose lengths of 7 ft spaced at 4 ft centres
3x2" spiked to 6x3
6x3
SIMPLE FORM OF STUNT END BOARD
Kerb
Angle 1 in 3
PLAN LOOKING DOWN ON EDGE OF A BAY OF CONCRETE AFTER STUNT END BOARDS HAVE BEEN REMOVED, SHEWING THE INTERLOCKING JOINT

FIG. 1—INTERLOCKING JOINT FOR CONCRETE ROADS

contracts ¼in. in 100ft. for every 50 deg. fall in temperature. Another reason was that when concrete of the usual working consistency is laid and punned in position, a laitance scum always works to the surface. This scum, he argues, being made up of inert or drowned cement having little or no strength, and when dry being readily rubbed away by the finger, practically acts like a coating of French chalk or anti-fouling paint in preventing a proper bond between abutting or superimposed layers of the concrete. Hence, as in masses of concrete there are bound to be cracks, the cracks will occur most readily at places where stoppages in the laying of the concrete has been arrested, as in the case of the end of a day's work, and, obviously, the longer the stretch laid in one day, the wider and more detrimental will be the cracks.

In his system of making concrete roads, therefore, Mr. Walker adopts the principle, specially advocated by Mr. H. P. Boulnois and other engineers, of laying the concrete in alternate bays, and not filling in the intervening spaces until the material in the bays first laid has set and undergone the greater part of its contraction. He furthermore makes the edges of the bays accurately vertical by means of special formers, as we explain later. The result, to use Mr. Walker's own words, is that the inevitable 1in. contraction in each stretch of road laid continuously in day-work lengths of 100ft. is split up into straight joints about $^{1}/_{16}$in. wide instead of large straggling cracks so detrimental to maintenance. The tar or bitumen coating afterwards applied has sufficient plasticity to span these narrow joints, which, however, not as expansion joints to provide for increases in temperature even in cases in which the road is laid, as is preferable, in the colder months of the year, when the resulting crack in the joint will be less than in roads laid in hot weather.

Instead, however, of laying the bays of his road square with the length of the latter, as is the usual custom, Mr. Walker lays them at an angle. His reason for so doing will, he says, be easily understood when it is recognised that, as each slab is practically a raft on a more or less movable foundation, it is desirable, for more reasons than one, not to have both wheels of a heavy axle load resting on the edge of a slab at one time, but rather to have the weight spread on two slabs.

A further innovation is that the edges of each bay or slab, in addition to being made accurately vertical, are also so formed that adjacent slabs are interlocked vertically and horizontally, one with the other, in such a manner that the weight of a rolling load passing over a joint is at all times supported by both slabs. If, Mr. Walker remarks, the alternate slab method of laying concrete with simple vertical joints be used, a heavy rolling load would tend to press down the edge of a slab and, passing across the joint, to knock off the arris of the adjoining unloaded and undepressed slab, an action which would soon result in the formation of innumerable holes in the surface of the roadway where the joints in the slabs came.

The actual arrangement of the interlocking joints and the shape of the stunt-end board used in forming the edges of the concrete bays so as to make the joints is shown in Fig. 1, which is self-explanatory. Reinforcement Mr. Walker regards as essential if good results are to be obtained, and any form of it may, of course, be employed, though that which Mr. Walker proposes is of the double-layer pyramidal mesh type with which the name of the Walker-Weston Company is connected. Whatever reinforcement is used, Mr. Walker insists that in no case should it be taken across the joints. Furthermore, no attempt is made to cause the concrete of one bay to adhere to that of the next bay. The joints between each are allowed to act as expansion joints; though, by laying the concrete in alternate bays, as explained above, the width of the cracks will never be great, and will always be bridged by the tar or bitumen coating. Mr. Walker also insists, moreover, that the whole depth of concrete must be laid at once so that there may be no horizontal joint in it, and so that the laitance scum will only form on the top from which it must be carefully removed before the tarring is carried out.

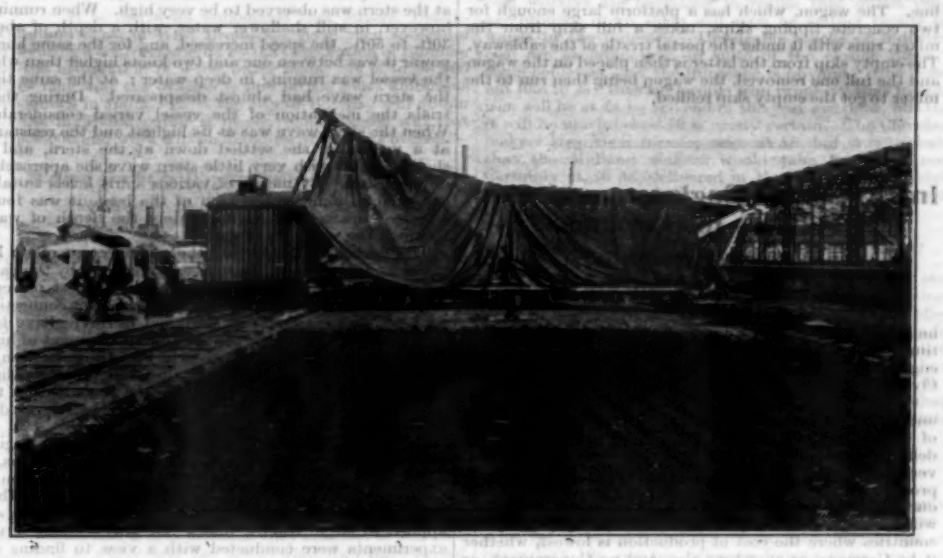


FIG. 4—WALKER CABLEWAY CRANE ENGAGED IN MAKING CONCRETE ROAD

As a suitable arrangement of plant for laying concrete roads from 30ft. to 50ft. wide by his method, Mr. Walker suggests that shown in Fig. 2. One of the chief difficulties originally encountered when dealing with the problem of laying a concrete road 30ft. or 40ft. wide in alternate bays was the lack of a machine capable of putting the concrete in place cheaply and expeditiously. Mr. Walker's solution of the difficulty is to use a special form of his cableway crane, the general principle of which was fully described in our issue for December 24th, 1920. The actual form designed for use in road-making is shown in Figs. 3 and 4. It is suggested that by using tarpaulins taken over the suspended girder the working space can be protected from the inclemency of the weather by the formation of a tent which can be internally illuminated. The crane is furnished with a travelling portal trestle on one side of the road, while on the other there is a trestle mounted on a travelling platform on which latter is the operator with two winch drums and an oil engine for actuating the cableway. The rails on which the trestles run need only be of light section and spiked to longitudinal planks so as to be easily taken up, transported and re-laid.

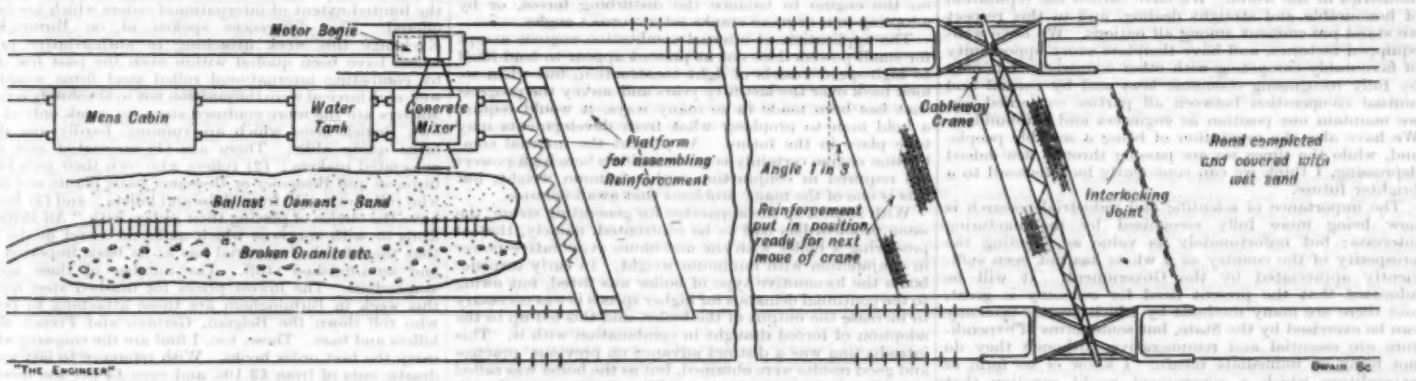


FIG. 2—LAY-OUT OF MACHINERY AND PLANT FOR MAKING CONCRETE ROAD

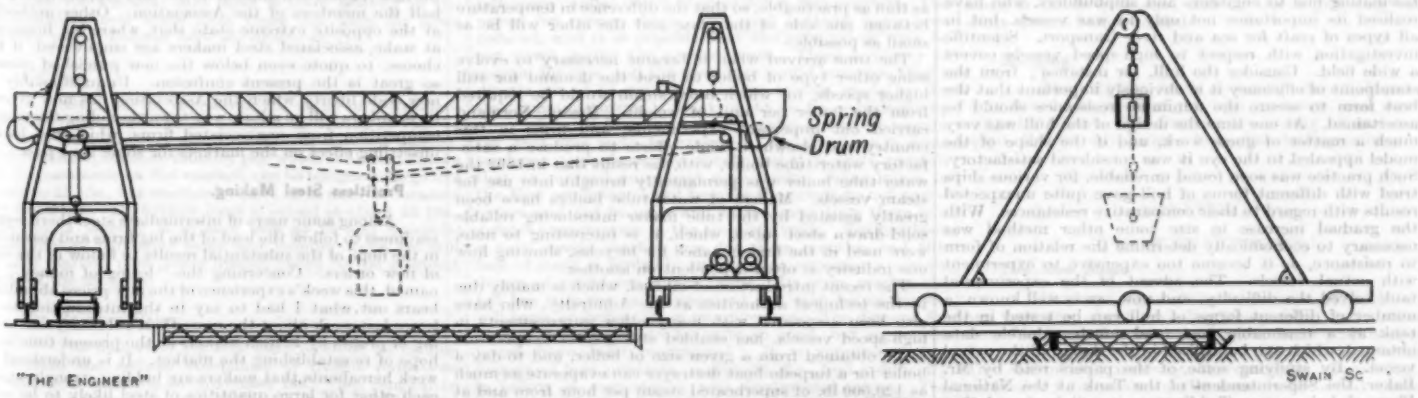


FIG. 3—CABLEWAY CRANE ADAPTED FOR MAKING CONCRETE ROAD

A light lattice girder with an attached cableway underneath is supported by block and tackle from the tops of the two trestles. This girder, also, need only be of light construction, as it has only to be sufficiently strong as a beam to carry its own weight. Furthermore, as the girder is flexibly supported from the trestles, it is of little importance if the girder be level or inclined or whether one trestle be moved somewhat ahead of or behind the other trestle. Hence, any required angle can be given to the bays of concrete.

In operation the concrete is conveyed from the mixer on a small motor-driven wagon running on a narrow-gauge line. The wagon, which has a platform large enough for two concrete tipping skips, takes a full skip from the mixer, runs with it under the portal trestle of the cableway. The empty skip from the latter is then placed on the wagon and the full one removed, the wagon being then run to the mixer to get the empty skip refilled.

Institution of Engineers and Shipbuilders in Scotland.

PRESIDENTIAL ADDRESS.*

By HAROLD E. YARROW, C.B.E.

During the whole history of the Institution, it is very unlikely that any of my predecessors assumed office at a time when the immediate future of shipbuilding and engineering was more discouraging, or a trip down the Clyde more depressing from an industrial point of view.

One of the chief causes of the present depression is undoubtedly the labour situation, and while it is not one of the functions of the Institution to take part in the deliberation of labour problems, nevertheless their solution very materially affects its members, for if the cost of production remains higher in this country than abroad our industries cannot flourish. Competition in the future will be very severe, and work will inevitably go to those countries where the cost of production is lowest, whether it be Germany or anywhere else, and no Government, or employers' federation, or trade union can alter this fundamental principle. Further, not only must we be able to produce at such prices as compare favourably with foreign competitors, but we must also be able to supply the article in a reasonable time. Many orders have been recently lost owing to the uncertainty of fixing a date for delivery, and the confidence in this country that many possessed has been shaken by the unsettled industrial situation.

I suppose no one in this hall doubts that prosperity will eventually return to the shipbuilding and engineering industry in this country. With the co-operation of the British workman we have built up some of the finest industries in the world. We have earned the reputation of honourable and straight dealing, and in this respect we stand pre-eminent among all nations. We have well-equipped factories, and have therefore every opportunity of favourably competing with other countries; but only by fully recognising economic laws and by cordial and mutual co-operation between all parties concerned can we maintain our position as engineers and shipbuilders. We have also the reputation of being a sensible people, and, while the times we are passing through are indeed depressing, I think we can confidently look forward to a brighter future.

The importance of scientific and industrial research is now being more fully recognised by manufacturing interests; but unfortunately its value as affecting the prosperity of the country as a whole has not been sufficiently appreciated by the Government. It will be admitted that the present need for economy is great, and there are many methods by which greater economy can be exercised by the State, but some forms of expenditure are essential and remunerative, although they do not bring an immediate return. I know of no form of expenditure which a government might sanction that would ultimately yield a better return than money spent in encouraging various branches of research.

It might be interesting to review briefly the effect of a certain branch of research that has been continuously carried out during the last fifty years in connection with high-speed vessels of the torpedo-boat type. It will, I think, indicate clearly how progress is dependent on research.

The question of high speed on water has always been a fascinating one to engineers and shipbuilders, who have realised its importance not only in war vessels, but in all types of craft for sea and river transport. Scientific investigation with respect to high-speed vessels covers a wide field. Consider the hull, for instance; from the standpoint of efficiency it is obviously important that the best form to secure the minimum resistance should be ascertained. At one time the design of the hull was very much a matter of guess work, and if the shape of the model appealed to the eye it was considered satisfactory. Such practice was soon found unreliable, for various ships tried with different forms of hull gave quite unexpected results with regard to their comparative resistances. With the gradual increase in size some other method was necessary to economically determine the relation of form to resistance, as it became too expensive to experiment with actual vessels. The advent of the experimental tank solved the difficulty, and now, as is well known, a number of different forms of hull can be tested in the tank at a reasonable cost, and much valuable data obtained, which can be utilised in the design of the actual vessel. By studying some of the papers read by Mr. Baker, the Superintendent of the Tank at the National Physical Laboratory, Teddington, it will be found that the average consumption in fuel over a wide range of ships has been reduced by fully 5 per cent., due entirely to improvements in the form of hull found desirable by running models in the tank, and 5 per cent. on the fuel bill may make all the difference in running a vessel at a profit or a loss.

During recent years considerable attention has been paid to the effect of shallow water on speed. In a fast vessel the wave-making resistance varies materially with the depth of water through which she is moving. Formerly it was generally accepted that in shallow water the speed was reduced, but trials with a destroyer over a course where the depth of water varied demonstrated that this was not altogether true. This vessel was about 220ft. in length, having a displacement of 400 tons on a draught of approximately 6ft. When travelling at 30 knots it was found that the speed was unaffected providing the depth of water was not less than 180ft. In shallow water the resistance increased as was expected, causing a corresponding decrease in speed, and at a depth of about 90ft. the speed was reduced considerably, while the wave at the stern was observed to be very high. When running, however, in still shallower water, with a depth of about 30ft. to 50ft., the speed increased, and for the same horse-power it was between one and two knots higher than when the vessel was running in deep water; at the same time the stern wave had almost disappeared. During these trials the inclination of the vessel varied considerably. When the stern wave was at its highest and the resistance at a maximum she settled down at the stern, and in shallow water with very little stern wave she approached an even keel. By means of various spirit levels suitably arranged to indicate the trim of the boat, it was found possible to ascertain approximately the depth of water in which the vessel was running.

The problems confronting the engineer are of no less importance than those that have to be solved by the naval architect. In designing an engine the greatest power is required with the minimum of weight. In this connection, probably the firm of Messrs. Normand, of Havre, have done more than anyone in the past in the development of high-speed reciprocating marine engines. An inspection of one of Messrs. Normand's torpedo-boat engines is a delight to any marine engineer, and shows the thought that this firm, through more than one generation, has devoted to its evolution and perfection.

As the speed of torpedo-boats increased, their engines were designed to give a higher number of revolutions, as complaints were frequently heard about the vibration on vessels with quick-running engines of high power. These objections were not confined to torpedo-boats, but also applied to large Atlantic liners. On this account certain experiments were conducted with a view to finding out the cause of vibration. It was found that vibration was the same when the vessel was at rest with the propeller removed and the engine running, as when it was being propelled in the ordinary way, which proved that the screw propeller, if well balanced, had no bearing on the problem, contrary to what was previously thought. With a single-cylinder engine the movement in the vessel was found to be simply vertical; with compound engines it was vertical, accompanied by a rocking motion; and with triple-expansion engines there was no movement of the engines at their centre of gravity, but there was still a rocking movement which made itself felt throughout the vessel. The vibration was ultimately minimised by the addition of suitable weights placed at certain positions on the engine to balance the disturbing forces, or by adopting four or more cranks set at correct angles.

The application of internal combustion engines except for small powers does not at present appear to lend itself to high-speed vessels of light construction, but when we look back over the last fifty years and survey the progress that has been made in so many ways, it would require a bold man to prophesy what fresh developments may take place in the future. At present the internal combustion engine certainly is not suitable where high powers are required in conjunction with minimum weight, but this is one of the many problems that await solution.

With respect to the apparatus for generating steam, the same problem has had to be confronted, namely, that of producing a boiler with the maximum evaporative power in conjunction with minimum weight. In early torpedo-boats the locomotive type of boiler was fitted, but owing to the continual demands for higher speeds it was necessary to increase the output of the boiler, and this led up to the adoption of forced draught in combination with it. This introduction was a distinct advance on previous practice and good results were obtained, but as the boiler was called upon for a greater output, trouble was experienced with leaky tubes. It was found by experiment that steel plate was much more susceptible to changes of temperature, such as occur with the admission of cold feed or cold air, than copper plate. Although copper expands more than steel it has a greater conductivity, and, therefore, when copper fire-boxes were used there was less trouble from leaky tubes than was the case with steel fire-boxes. If, however, steel fire-boxes are to be used, these experiments clearly show the advisability of making the tube plate as thin as practicable, so that the difference in temperature between one side of the plate and the other will be as small as possible.

The time arrived when it became necessary to evolve some other type of boiler to meet the demand for still higher speeds, for which more steam would be required from the boiler per unit of weight. Messrs. Normand carried out important experiments, and firms in this country and elsewhere made efforts to produce a satisfactory water-tube boiler, with the result that in 1892 the water-tube boiler was permanently brought into use for steam vessels. Makers of water-tube boilers have been greatly assisted by the tube maker introducing reliable solid-drawn steel tubes, which, it is interesting to note, were used in the first instance for bicycles, showing how one industry is often dependent on another.

The recent introduction of oil fuel, which is mainly due to the technical authorities at the Admiralty, who have also been associated with many other improvements in high-speed vessels, has enabled still greater evaporation to be obtained from a given size of boiler, and to-day a boiler for a torpedo-boat destroyer can evaporate as much as 120,000 lb. of superheated steam per hour from and at 212 deg. Fah., representing between 10,000 and 11,000 shaft horse-power, the amount of oil consumed per hour being between 4 and 5 tons.

* Read October 19th. Much abridged.

The Associated Society of Locomotive Engineers and Firemen has its headquarters in Leeds. It has now bought Sir Thomas Beecham's house in Hampstead in order to carry out a recently made decision to remove the offices from Leeds to London.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(*From our own Correspondent.*)

Export Bounties versus Trade Credits.

Among the various propositions for engineering the re-establishment of trade which are at present receiving attention hereabouts, some prominence has lately been given to a new policy which, put shortly, amounts to the granting of a bounty on exports. It is recognised that the real solution of the unemployment problem is an improvement in trade, and as measures for this purpose take some time to develop, it is very doubtful whether any satisfactory result can emerge until it is too late. Parliament is seeking a real, not a hypothetical, scheme for establishing credits for foreign buyers. Manufacturers have had Sir Edward Mountain's scheme and the Ter Meulen scheme before them. But neither of these proposals has the slightest chance of success without tremendous organisation, and such organisation has not even been seriously attempted. In the circumstances, a question which Birmingham manufacturers are now asking is, Have we exhausted the possibilities of a bounty on export accompanying a system of credits? The matter is one quite worthy of some consideration. We want to ensure buyers, and as long as costs of production at home are so high, we can reach lower selling prices abroad at once only by bounty on exports. It is being pointed out here that Germany utilised this part of the international machinery of trade with remarkable success, and the circumstances of our nation at present make a scheme of bounty on exports well worth examination. It may be vicious; it may be everything to which objections may be urged; but is it worse than unemployment doles? it is being asked here. The suggestion in this district is that bounties might first be confined to colonial exports, and it is suggested that some such scheme could be organised much more quickly than any system of increased credits to Central Europe. The exchange difficulty is absent as regards colonial trade, and the Birmingham manufacturers who back the bounty proposition are pressing the question. Is it worth while endeavouring to make colonial buying prices and British selling prices meet?

The Race in Steel Prices.

The race in steel prices continues to be the one outstanding feature of the Birmingham iron market. Peculiar zest has been added to the already marvellous situation by the news from America of the full determination of the Transatlantic steel masters to enter into the international competition for orders with the idea of seriously cutting prices. Never was a time like the present for strange spectacles of variously priced contracts for the limited extent of international orders which are being offered. The differences spoken of on Birmingham Exchange this week attaching to authoritative prices which have been quoted within even the past few days by competing international rolled steel firms would be well-nigh farcical were the position not so absolutely serious. Matters are the more confused since, to speak only of our own British firms which are running, hardly any three firms quote alike. There are (1) associated and non-associated makers; (2) rollers who own their own blast-furnaces and Bessemer or Bessemer basic plants and those who roll down only from slabs and billets; and (3) buyers have the choice of placing their orders with "All-British" firms or with concerns which make no secret of the fact that their finished material has as its basis imported raw and semi-finished stuff. The number of these last is stupendous. The lowest prices for finished steel quoted this week in Birmingham are those attaching to people who roll down the Belgian, German and French slabs, billets and bars. These, too, I find are the concerns which carry the best order books. With reference to last week's drastic cuts of from £3 10s. and even £4 per ton down to £2, it is now stated that the instability of the market position and the competition from outside firms have to a great extent deprived the All-England Makers' Association of its power of initiative, and it was thought its solidarity would best be preserved by making the bonds very loose. It seems to be largely optional even among the associated houses either to accept the full extent of the official reductions or still to struggle for a better price. Some *habitués* on this Exchange go so far as to assert that the new Association minima do not find support from above half the members of the Association. Other authorities at the opposite extreme state that, where big business is at stake, associated steel makers are empowered, if they choose, to quote even below the new published minima, so great is the present confusion. Unquestionably the new wide liberty which the Association has now given to its members will go a long way towards ending the unequal competition from unassociated firms, which has had an unsettling effect on the markets for some time past.

Profitless Steel Making.

Among some users of intermediate steel there seems a readiness to follow the lead of the big firms and lose money in the hope of the substantial results to follow in the shape of new orders. Concerning the "losing of money" just named, this week's experience of the new prices abundantly bears out what I had to say in the introduction to my letter last week about the more than voluntary surrendering of profits by British makers at the present time in the hope of re-establishing the market. It is understood this week hereabouts that makers are bidding strongly against each other for large quantities of steel likely to be called for in connection with Admiralty orders about to be placed. They are also keen on keeping out joists and other heavy building material lately coming in in rather large quantities from Belgium. Some Midland steel millowners offer to do business at the minimum rates in the hope that it may prove a new starting point and hasten the reduction of production costs. Others are definitely not prepared to face the heavy loss entailed. These last declare, for example, that the cost of re-rolling billets into angles is something like £5 under existing conditions, and, adding this to the price of the billets—£8—there is a heavy balance

to the bad if angles are to be sold at the new Association figure of £10. Some Midland makers again certainly do not see their way to quote so low as £10 10s. for bridge and tank plates, while the new price for boiler plates is declared to be a very lean figure at £16. The new cuts are freely recognised as a big endeavour on the part of the great steel-making concerns to create employment and get the metal-working trades in action again. But it is held that most of the advantage will still rest with the self-contained productive units which consume their own output, and from careful and disinterested inquiries which I have myself made this week there can be no question of the honesty of this argument. Many manufacturers seem to feel that no commensurate advantage is to be expected from the application of the £10 rate to small orders for angles, and similar doubts are expressed with regard to the other minima announced. The Staffordshire reduction in iron gas tube strip to £15 does not appear to have brought out much new business, as steel strip can be bought as low as £11 10s.

Iron Trade Improvement.

Galvanised sheets appear to be taking the lead in any iron trade improvement which is now taking place. Strange as it almost appears, considering the general depression which one has fully recognised has of late marked the galvanised and black sheet trades, one very large concern which rolls steel sheets for galvanising is reported this week to have forty-five out of its forty-eight mills at work. The general impression on Birmingham Exchange is that the concern indicated is one now established in Lancashire, but which previously ran in South Staffordshire. This impression is strengthened by the information that a week or two ago the owners of the Wolverhampton Corrugated Ironworks at Ellesmere Port, who are associated as black sheet and galvanised sheet makers with John Summers and Sons, Limited, of the Shotton Ironworks, Cheshire, categorically stated that orders were coming in faster than the firm could produce. The problem at the moment was, the management boasted, how to increase production. Further, they expressed the hope that "before Christmas they would have the whole plant in full operation, and it would then be producing much more than in pre-war times." The total number of mills operating in the all-England steel sheet trade is now officially reported to have been 361 at the end of September, which represents an increase of 41 during that month. The steel sheet trade now looks forward to some progress. Prices of galvanised sheets continue to fall, and the quotation for doubles—i.e., 24 W.G.—is now freely given at £18 10s. to £19 f.o.b. Liverpool. A few makers quote £20, but they are a dwindling minority, and then the quotation only applies to superior qualities. Comment has been aroused on Birmingham Exchange by the reduction of 30s. per ton just announced in black sheets in the West of Scotland, making the new basis £13 15s., but exactly how far this will affect Staffordshire sheet prices is not yet ascertainable. The Indian and Far Eastern buying of galvanised sheets has been a feature of the market of late, but it has been only possible to do business by making considerable price concessions.

Ironmasters' New Demands.

The need for lower wages, cheaper coal, and railway rates is emphasised on all hands this week by Midland ironmasters. The iron and steel trade, having shown its readiness to pay the price of deflation, can urge with a good grace that the railways and the docks should come in and help. There is a sanguine feeling that in the new trade advancement proposals which they have been formulating, the rail and dock interests will not shirk their responsibilities. Among constructive—i.e., bridge and girder—engineers and roofing firms the feeling happily appears to prevail this week that the new minima in steel prices affords a good basis for business expansion.

Bar Iron.

So far from having settled a selling standard, recent reductions in iron prices appear to have given a new impetus to the downward movement. The price of £14 10s. fixed by the bar makers for unmarked bars is being undersold, especially by firms not connected with the Association. Merchants state that they can buy as low as £13 15s. and even lower prices are mentioned. The reduction has led to the placing of some orders, several forges being at work this week which have been idle for some time. The Staffordshire ironmaster is showing more keenness for business, and there is more activity in the Staffordshire iron trade than there has been for some months past. Belgian bars are dearer at £10.

Pig Iron.

About £5 5s. represents the value of Northamptonshire forge pig iron at furnaces so far as it can be deduced from the very small amount of business passing. The Northamptonshire foundry pig, which is about to make its reappearance on the market, can be bought in large lots down to £5 15s., but smelters require £6 or more at furnaces for small lots. Derbyshire forge is priced at about £5 10s., and No. 3 foundry is in slow sale at £8 and upwards. Staffordshire part-mine forge and foundry irons are still off the market, none being offered owing to the stagnant state of the furnaces.

The Railway Rates.

The makers of pig iron have received an intimation from the railway companies of freight reductions coming into operation on November 1st. They range from 16⅔ to 20 per cent. on iron ore and limestone. The total effect of this concession will not exceed a few shillings per ton in the cost of production. No concession is made for the carriage of fuel or for that of pig iron, for which, as I said last week, Midland ironmasters have been agitating. The trade is showing a good deal of resentment over the refusal of the railway companies to assist trade recovery by concessions of a really important character. One smelter points out that his carriage charges for sending a ton of pig iron a journey of less than 100 miles are very nearly £1 per ton. It is considered here that the railway policy is decidedly short-sighted, in view of the very large quantities of foreign pig iron coming into the country. The carriage of a ton of pig iron, if made in this country, would involve the conveyance of something like three tons of ore, with fairly large quantities of limestone, sand, and other materials, employing a lot of rolling stock now idle. Ironmasters are very keen on reaching economic selling prices, but they consider themselves helpless in attaining this business basis without substantial help from the railway companies.

Big Iron Pipe Contract.

It is this week announced that Messrs. Braithwaite and Sons, of West Bromwich, have been successful in securing a contract offered by the Corporation of Bombay for the installation of a big water main. It is to be 105 miles long and the scheme is one of the most ambitious yet known in India. By it the city of Bombay will obtain all the industrial power it needs. The scheme will cost £1,500,000 and work will be found for thousands of men.

Midland Coalfields Disputes Settled.

I am glad to be able this week to report that the disputes in the Midland coalfields have ended happily as I intimated last week it was hoped and expected they would. At Cannock Chase, where the method of filling coal was the bone of contention, a mutual arrangement has been made which has obviated the necessity of serving notices on the men. At Stanley's Nuneaton Colliery, where the owners intimated that unless the men were prepared to accept a reduction in wages they would be compelled to close down, a system of working for a temporary period has been agreed upon. In the Old Hill district there is much dissatisfaction amongst the miners with regard to allowance coal. According to an old Black Country custom, single miners have been given allowance coal up to now, but the colliery proprietors have recently declined to continue the practice, with the result that the matter is to be taken before the local County Court Judge for his decision. The married miners still receive their allowance. The miners regard the allowance as part of their wages, and if it is withheld they consider it will be a reduction in wages over and above what they have agreed to.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER, Thursday.

Iron, Steel and Metals.

THE markets for iron and metals do not show any very serious change, with the exception of the severe cut in the manufactured steel prices. Otherwise, dullness and depression are the main features, and there is no sign yet that any definite improvement in consumption has taken place. The disintegration of the European currency systems goes steadily on, and it looks as though most European trade will soon have to be carried on by barter, and entirely without the help of currency or bills of exchange. This is so serious a matter from the point of view of the trader that it demands immediate attention from all the statesmen of Europe.

Metals.

The movements in the copper market have been very slight, and it seems probable that the recovery from low prices will be delayed still longer. It is reported from America that a movement is on foot to amalgamate the more powerful copper companies, with a view to improve the situation and keep the market steadier. It is, of course, possible that a copper trust on the lines of the steel and oil trusts may be organised, but it may be doubted whether the American domination of the copper trade is so complete as it once was. The state of demand for copper in the European industries is not at all satisfactory, and it is seriously affected by the large quantity of scrap which is now on the market. Some time must elapse before this material is assimilated by industry, and perhaps a revival in the copper market may have to wait until this is accomplished. It is said that domestic consumers in America have been buying more copper lately, and it may be true that, tempted by low prices, consumers have been putting more money into stocks of copper, in the expectation that prices cannot fall very much, whatever may happen. This would probably be done here also, but spare capital is not so plentiful in this country. The prices for copper sheets, rods and bottoms have been reduced, and it is possible that the tube prices may be put down during the present week. There is plenty of margin for this, and the consumer would maintain that a drastic cut of 25 per cent., similar to that made by the steel manufacturers, is what ought to be considered by the makers of brass and copper tubes; but we cannot say that this is to be expected. In tin there is some tendency towards improvement, and it is quite possible that an upward movement may begin. Some mines in the East are being closed because the prices do not pay—or are said not to pay—and at the same time there is a greater consumption in the tin-plate trade. Tin has been a very steady market now for three months, and this fact of itself is probably sufficient to engender a certain degree of confidence in the prices. In every market the fall has to come to an apparent full stop before buyers will begin to believe in an improvement. The demand for lead is thought not to be quite so good, but so far the prices have been maintained. It is significant that makers of lead products, carbonate, &c., find a difficulty in selling in competition with continental prices. The bringing of lead prices to a level consonant with copper and spelter prices has been delayed, but it may not be delayed much longer. In the spelter market there is practically no change, but the demand from galvanisers continues to grow. The effect, however, is counteracted by the very poor consumption in the brass industries.

Foundry Iron.

The position here in the foundry iron market is much as it was. Makers are quoting the same prices, and buyers are just taking a truck or two as they have need. There is no forward business, simply because no buyer has any confidence in the prices. Hence, it is more than usually difficult to get at the lowest prices which would be accepted, for it is unreasonable to expect a maker of pig iron to quote a low price for 10 tons. There is a general feeling here that if an order for 500 or 1000 tons for delivery over the next few months were to be had, a very considerable reduction might be obtained. It is clear that in some respects the actual costs of production will be lower, and it is probable that fuel costs will be reduced considerably. There are signs that both coalowners and coal workers are beginning to realise that unless prices are brought down there will soon be neither profits nor wages in the industry. Unsaleable stocks of industrial coal are accumulating, in spite of the closing down of some collieries, and the inference is obvious. One would not like to say that the people who prophesy that foundry iron will be at £4 by the end of the year are right, but that it will be much below £6 is pretty certain. The Cleveland makers keep their furnace price at £6, but it is probable that the Midland makers would take less even now. Certainly at £6 5s., delivered in Manchester, No. 3 might be bought, and probably at £6, and this would mean £5 10s. at the furnaces.

Finished Material.

The reduction in the prices for sectional steel and common plates has not yet brought much business in this market. Buyers may be waiting to see what effect a fall in costs of production may have, although this fall has been anticipated in the present prices for sections and for ship plates. The price of boiler plates may, however, be reduced; indeed, this ought to be done. It is said that continental prices are a little easier, perhaps because fewer inquiries are now going from this country to the Continent.

Scrap.

The market for scrap remains dull and quiet. The demand for scrap steel may be better, but there is a lot yet to be sold, and the prices, delivered, do not rise beyond £3 10s. per ton, whereas foreign basic iron costs over £1 more than this, even under the most favourable circumstances. The revival in wrought scrap is waiting for a better demand for finished iron. Cast scrap is, of course, dull and difficult of sale, because the foundries in the district have so little work. The demand for textile engineering castings is the only demand which is alive.

BARROW-IN-FURNESS, Thursday.

Hematites.

There is no improvement to report in connection with the general condition of the hematite pig iron trade of this district. There are in all eight furnaces at work, but some of them are only working on easy blast. The orders held are for special deliveries of iron that cannot be done without. New business is slack, and the disposition of buyers still to hold back with a view to placing contracts at a much lower figure is marked. Lower rates can be expected to some extent, but it is not an easy matter to reduce them on the part of smelters, who are faced with many difficulties.

Iron Ore.

The demand for iron ore is confined to local smelters, and their requirements are not by any means large. Still, there is a little more activity at the Furness mines, the pit at Newton now being engaged, the other mines where ore is being raised being at Roadhead, Anticross, near Dalton, and at Pennington, near Ulverston. The importations of Spanish ore have been quiet of late.

Steel.

The steel trade presents no new features this week. At Barrow and Workington there is a fair amount of activity in some of the departments, but the demand is still very quiet. Last week's reduction of prices may induce more business, as it narrows the margin between the prices quoted by foreign competitors and those of local manufacturers.

Shipbuilding and Engineering.

The shipbuilding trade is fairly well employed so far as fitting out is concerned, but on the slipways there is much quietness, and in the engineering shops short time is being worked.

Shipping.

The shipping trade is quiet. Small shipments were noted last week of pig iron coastwise, and a small cargo for Ghent. The imports are mostly oil and motor spirit, Barrow now being a large distributing centre.

SHEFFIELD.

(From our own Correspondent.)

The New Ships.

DEFINITE signs of the trade recovery in this area are very shy about revealing themselves, but one continues to hear of quite bright spots developing here and there—harbingers, it is to be hoped, of better times coming. The saw-making industry, for example, appears to be particularly fortunate in the amount of actual business coming in, and I am told that some firms are "pulled out of the place" with work. Similarly, there seems to be a revival of activity in hammers and other small tools, and as a good proportion of the orders is for the home market, it looks very much as if various engineering and allied firms throughout the country are preparing to get busy. It is also suggestive of the building trade pulling itself together. Chief interest this week, of course, has been in the placing of the battle-cruiser contracts, though whatever activity these bring about must not be confused with a genuine trade recovery. They will bring work certainly

and a large percentage of the £30,000,000 which is said to be involved will be paid away in wages; but it is in the department of peaceful industry that the real recovery must be looked for. At the moment of writing definite news had just arrived that the construction of one hull and its machinery had been placed with John Brown and Co., that half the armour plate contract had been given to Browns, Cammells, and Vickers, and that the last-named firm was to make half the guns required. The fact that one-quarter of the armour plate will be made at Beardmores is also of interest to Sheffield, seeing that Vickers hold half the ordinary shares in the Clyde company.

The Cost of Production.

What manufacturers here are most concerned about, however, is how the cost of living can be more closely reconciled with the vital necessity of a further reduction in wages, in order to assist in bringing down the cost of production. The difficulty is that Labour is very sceptical about the Board of Trade figures, which are not borne out by the prices asked by retailers. What some influential industrialists in this district feel is that the wide margin of profit retained by retailers generally is preventing the realisation of the fall that has taken place in wholesale prices, and that the effect of this is to stiffen the backs of the workers against the acceptance of any further reduction in wages. This "profiteering" on the part of the retailer is held to stand directly in the way of that general industrial recovery which it is believed would commence if costs of production were an attractive instead of a repellant factor. I do not know, but I believe steps are being taken to urge this point on the Government with a view to some drastic action being taken to relieve the position.

Patchy Conditions.

In the meantime many manufacturers are finding it extremely difficult to avoid pessimism, though considering the adverse position with which they are confronted, it is surprising to find so many optimists among them. Crucible steel departments can scarcely be said to be showing any substantial sign of improvement, for what business trickles in appears easily to be supplied from stocks, which are known to be heavy. This is an instance in which "cuts" in prices seem of very little effect in inducing home and oversea consumers to place fresh business, for a recent further fall of 6d. per pound appears to have made practically no difference to the market. It is probable, however, that the high-speed steel industry of Sheffield may suffer a good deal from the unavoidable conditions that prevailed during the war. Before that event, for example, France and the Colonies bought most of their high-speed tool steel here, but in the days when our hands were full with urgent munition work we had to send experts to instruct them how to make the steel for themselves. Now, of course, they know and Sheffield makers are the victims—if it be permissible to speak of the matter in that way. Some of the ordinary tool steel manufacturers are very poorly off for orders, which seems rather to contradict what I have written above; but it must be borne in mind that trade was never in such a patchy condition. An inquiry into the state of business leaves one with the impression of being in a bank of fog which suddenly lifts only to descend again. There are high-speed steel makers even who tell me they are quite busy, but they are very exceptional. Hardly any additional open-hearth steel furnaces have been lit up since I last referred to the matter, which means that barely more than one-third of the total capacity is being operated. The production of steel for the new ships, however, should make a great difference to the activity of the acid furnaces.

One of the Busy Firms.

The most comforting thought is that the back of the continental competition—in the severe form experienced for so long, at all events—appears to have been broken, though it cannot be said that that has proved much of a bull point yet. Nevertheless, the fact that quite a small difference exists now between the quotations of home and foreign iron and steel is bound to tell in the immediate future, especially since, as I have often mentioned before, the home production has a very decided advantage in the matter of quality and delivery. Railway steel continues in fair demand, though not nearly so heavy as had been confidently predicted, while orders from tramway undertakings keep trickling in, though, in the case of both, the capacity of Sheffield firms for turning out larger quantities than at any time in pre-war days makes quite a fair demand look rather small. Rolling stock builders are pretty well employed at the moment, and probably will be for some time ahead, but fresh business is not too brisk. Recently, it may be recalled, I mentioned some important rolling mill construction just completed at the works of the Brightside Foundry and Engineering Company. Most of it was for local firms' developments, notably at Hadfields, where preparations have been made for steel rail rolling on a large scale, but some was on overseas account. The Brightside people now tell me they have secured a contract for the supply and erection of the complete installation of the superheated and saturated steam pipe work, valves, &c., for the Cossipore Electric Generating Station, Calcutta. The contract figure is over £8000 and the work is connected with new 15,000 and 6000-kilowatt turbines. The firm, I hear, is doing quite well just now in that class of work, at the present moment having similar contracts in hand at the Ogmore Vale power station and the Dublin, Birmingham, Kettering, and Doncaster Corporation electricity stations. One of the Brightside's subsidiaries, I believe, is Moorwoods, the makers of such things as cooking ranges, canteens, and heating installations for warships, so that one would imagine there is a good chance of some of that kind of work required for the new battle-cruisers coming to Sheffield.

Cammells' Indian Enterprise.

For some little time preparations have been proceeding in the armour plate making departments here for the large requirements arising out of these Admiralty contracts, and by the new year it is expected they will be getting quite busy again, for there is still a certain amount of business in hand for Japan, and somehow or other this kind of work begets work. The contracts will also make tool manufacturers busy and may give a useful fillip to the high-speed steel people, while the table needs of four huge vessels, each with a complement of, say, 2000 men, will bring some good orders to the cutlery and electro-plate industries of Sheffield. One of the interesting events of the week has been the announcement that Cammell, Laird and Co., in conjunction with Bird and Co., of Calcutta, have registered at the latter place the United Steel Corporation of Asia, Limited, with a capital of 20 crores of rupees. Cammells are to design, erect and staff the works, which are to include the most modern plant and labour-saving devices, and to have an ultimate output of from 600,000 to 700,000 tons of pig iron and 450,000 tons of finished steel per annum. Ample supplies of coking coal, iron ore and limestone are said to be within easy reach of the works site, and in addition to the board of directors in India an advisory committee has been set up in London, the seven members including Mr. W. L. Hichens and Mr. J. M. Allan respectively, a chairman and a managing director of Cammell, Laird and Co. It appears, therefore, that the decision made by the Sheffield firm some time ago to establish a works near Calcutta, under the auspices, I believe, of a separate company registered in India, has been followed by very rapid and important developments. Cammell's Indian interests seem to have been under continual growth of late years, one of the most prominent directions being in the construction of rolling stock. At the Birmingham works of the Midland Railway Carriage and Wagon Company, now controlled by Cammells, as well as at the latter's large new place at Nottingham, an enormous number of covered and open goods wagons have been constructed for the Bengal-Nagpur and other Indian railways.

Overseas Trade.

The official returns of overseas trade for last month, while extremely depressing on the whole, contains a few cheering features, and are also interesting. The aggregate tonnage of iron and steel manufactures, for instance, increased from 64,000 tons in July to 76,461 tons in August and 133,324 tons in September. This last is a little more than one-third of the tonnage exported in September, 1913, although the declared value was only 3 per cent. less. This advance from month to month is a hopeful feature, but it is depressing to find that the import tonnage exceeds the export tonnage by 50 per cent. Coming to details, the most striking advance is in galvanised sheets, which doubled the trade of August, and was nine times as much as in July. Other notable increases were tinned plates, tubes, pipes and fittings, rails, and manufactured steel. The general level of declared values per ton of iron and steel goods shows a decline of 30 per cent. compared with a year ago. It is pointed out in the *Board of Trade Journal* that comparisons of the values of imports and exports this year with the corresponding figures for 1920 are misleading owing to the very large reductions in prices. Value totals would, in this circumstance, decrease even if the quantities were maintained at the same level. It is noteworthy that only 613 motor cars were imported into this country in September, whereas the number in the corresponding month of last year was 2069. Machinery in the same period fell from 7700 tons to 2600 tons. On the other hand, iron and steel goods went up from 103,300 tons in September, 1920, and 141,500 tons in August of this year, to 206,100 tons.

NORTH OF ENGLAND.

(From our own Correspondent.)

A Gloomy Position.

There is still no gleam on the horizon heralding the dawn of a brighter day for industry. The position is indeed very discouraging and gloomy. Two more furnaces have been put into blast during the week, but the ironmasters generally are still firmly adhering to their resolution not to re-start more furnaces until working costs are substantially reduced. The drastic cut in steel prices, which became operative last week, has not yet had an appreciable effect on the demand, and many of the works are experiencing great difficulty in keeping their plants going even on short time.

Miners Willing to Make Sacrifices.

The miners in Northumberland and Durham have intimated to the coalowners that they are willing to make local settlements concerning wages within the scope of their trade constitution in order that collieries now closed may be reopeneda nd others prevented from ceasing operations for the present. Tonnage rates are being considered, and negotiations are proceeding locally to see how far these can be reduced to meet the economic situation.

Cleveland Iron Trade.

The Cleveland iron trade position is very disappointing. Manufacturers declare that they are producing at a loss; yet, even so, they cannot sell all the iron they are making, and they certainly will not go on indefinitely maufacturing for stock whilst costs of production are so high. The relief afforded by the prospective fall in railway rates on limestone and ironstone on November 1st is so trifling as to be almost negligible, and ironmasters are frankly disappointed at the limited extent of the cuts. It is calculated that to the Cleveland makers the saving in railway charges will be equal to about 2s. per ton, whereas successfully to meet foreign competition the reduction in selling prices will need to be nearer 20s. per ton. However, whilst the need for drastic cuts is admitted, no move in that direction has been made. Owing to its great scarcity No. 1 Cleveland foundry iron commands 125s. per ton for home consumption and 130s. for export, whilst No. 3 Cleveland is at 120s. per ton, with a premium of 5s. for export. All other qualities, however, are plentiful, and there is little demand. No. 4 foundry is kept at 119s. per ton and No. 4 forge at 112s. 6d. per ton; but it is pointed out that Derbyshire forge is being offered at 105s. per ton, and no doubt Cleveland forge iron will have to fall before makers can hope to dispose of their stocks. Mottled and white iron are nominally at 112s. 6d. and 110s. per ton respectively, but these prices would be shaded.

Hematite Pig Iron.

An easier tone prevails in the hematite pig iron trade. Makers are not selling all they produce, and whilst mixed numbers are quoted at 125s. there is such competition that business for any substantial quantity could probably be done at 120s. The foreign market, however, is practically closed, and the home demand very limited. Hopes are expressed that the placing of the orders for battle-cruisers will speedily benefit the steel trade and improve the demand for hematite, otherwise one or more furnaces will have to go out of operation.

Iron-making Materials.

One of the hematite makers' difficulties is that they have high-priced iron ore to take out under old contracts, and this keeps up the cost of production. Ore prices are now falling, and a transaction is reported from Bilbao in Rubio ore at 17s. 6d. per ton, which is equal to a c.i.f. price of 25s. 6d. The local quotation is 27s. 6d. c.i.f., though possibly 27s. would not be refused. Coke, unfortunately, is no easier in price, and so long as it is kept at 32s. 6d. per ton delivered at the works the chief obstacles to an industrial revival remains to bar the path.

Manufactured Iron and Steel.

Little improvement can be reported in the manufactured iron and steel trade. The cuts in prices have certainly resulted in more inquiry, but all the business booked does not in the aggregate amount to very much. Only small orders involving constant changes of the rolls are being placed as yet, and works are simply operating from hand to mouth. There is, however, the definite fact that steel prices have been cut to the irreducible minimum, until coal and wages fall considerably, and if buyers realise this it may lead to great activity.

The Coal Trade.

There is as yet no sign of improvement in the position of the northern coal trade, and there is a considerable loss of time at the pits. Except for the running of contracts previously booked very little business, if any, is possible for prompt. There is no appearance of anything like stability in values either for next month or December, to say nothing of next year. The collieries are more or less willing to discount their October prices to the extent of 2s. to 3s. per ton, according to class, and business has been reported on the basis of 24s. 6d. and 25s. for best Northumberland steams, but this concession is not big enough to inspire confidence in the minds of merchants and exporters, who are keeping in close touch with their continental clients, and who so far decline to enter into definite negotiations on these lines. Buyers abroad expect to cover their requirements at much lower figures, and, notwithstanding that deals in good class Durham unscreened have been closed at both 17s. and 17s. 6d. over the first half of next year, they are disinclined to repeat at these figures and are talking about waiting for a 15s. market, which, in their opinion, is only a matter of a short time. The trade for the early part of next month is of very small proportions. Collieries and exporters report an almost entire cessation of purchases. All classes of steams, except smalls, are badly in need of orders, while the bunker trade is phenomenally slack. There is no sign of betterment in the coke market except in the case of gas coke, which is in good demand at top figures.

SCOTLAND.

(From our own Correspondent.)

Work for the Clyde.

The placing of two contracts for new battleships with Clyde yards gives cause for considerable satisfaction in this district, since the shipbuilding and allied industries are sorely in need of work. John Brown and Co., Clydebank, and the Fairfield Company, Govan, have received official confirmation of their contracts. The first-named firm was responsible for the building of the Hood, Repulse, Tiger and Inflexible, and the engines for the Queen Mary, while the Fairfield Company constructed the Renown and Indomitable and the engines for the Indefatigable. It is computed that the shipyard workers and steelworkers engaged will absorb £15,000,000 in wages, or, in other words, a sum approximately equal to £10 per head of the population in the area represented by the successful yards.

Failure of Petroleum Boring at West Calder.

The work of boring for oil in the shale district at West Calder has been prosecuted for a few years. Ever since the beginning of operations, geologists have disagreed as to the probability of getting petroleum in the strata. Several times during the period traces of oil have been found, but since within the past few months no traces of oil were found at a depth of between three and four thousand feet, it was feared that failure was imminent. Boring has now been stopped, and the work of drawing the pipes to the surface has commenced.

Another Bid for the Subsidy.

From the latest announcement of the Miners' Federation, it would appear that that organisation has not yet abandoned hope of getting hold of the £10,000,000. subsidy. It seems incredible that such an organisation, intimate with the experiences of the coal trade within the past few months, should willingly shut its eyes to the real nature of the depression, and attempt to maintain a fictitious prosperity at the expense of an already overloaded community. The shorter day and reduced outputs have played havoc with the coal trade. Other trades and

businesses of all description have suffered, and the taxpayer is unable to shoulder the burden of the subsidy, while the foreigner is no more able to pay inflated prices. Even taking the scheme at its face value, it is questionable if the selling price mentioned would be nearly low enough to foster trade. In the words of one authority, "The sum quoted is barely 10s. per ton reduction in price on a month's output of coal, and not even the most pronounced optimist can imagine that a guaranteed reduction in price for one month with the prospect of a return to economic prices at the end of that period is sufficient to induce the wheels of industry to revolve at full speed. It is possible for the men to concur in the abolition of the seven hours' day, if only temporarily, in order to restart industry and reconstruct the coal trade. No subsidy can do this. If a subsidy is granted, industry must eventually pay it." Fuel at a price nearer 20s. per ton is necessary to give industries a chance, and even at that figure a 25 per cent. advance at least on pre-war levels on the best qualities of fuel would be shown. It would appear as though the Miners' Federation was determined even yet to fight for what to any other mortal is a sheer impossibility.

Steel and Iron.

Apart from a further reduction in prices, there was no feature of interest in the Scotch steel trade during the past week. The industry on the whole is in a lifeless condition, and it is with the greatest difficulty that any of the works are kept going. Business cannot be secured at a price showing a profit or even at a figure calculated to cover expenses. Continental quotations still show an upward tendency, and some measure of satisfaction may be gained therefrom. Fresh orders are a necessity, however, and in this connection some relief may be gained when the Admiralty work on the Clyde is commenced. The different departments of the iron trade are in a similar position. Pig iron is very quiet, and even with only a very few furnaces in blast the output is beyond requirements. Home consumers are still forced to use imported material in view of the price of the home product, which, in spite of various reductions, is still far beyond foreign quotations.

Coal.

Conditions in the coal trade have been unsatisfactory long enough, but the situation has been considerably aggravated by the wages award. Since the announcement of Sir Wm. Plender's decision, nine more Scottish pits have closed down, making a total of fourteen since the beginning of October. The owners contend that it is quite impossible to keep going except at a heavy loss, and that the closing down of their pits is inevitable. Meantime, in spite of reduced outputs and irregular employment, the supply of fuel is ample for all requirements. Industrial orders are meagre, and house coal business is below normal. Shipments have improved somewhat during the past week, all coal being comparatively busy in this direction. Taken all round, the number of steamers loading has been smaller, but in some instances the cargoes have been heavier. Aggregate shipments for the week amounted to 206,632 tons, against 193,966 tons in the preceding week and 347,273 tons in the same week in 1913.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade.

The statement of the miners' leaders that the coal industry was never in a worse plight will be agreed with by big coalowners and all who have to do with the commercial side of the trade, but the remedy, contained in their proposals submitted to the Government, will not find much, if any, support, and it is very doubtful whether the Government will be disposed to continue the subsidising of the industry. The idea of the Miners' Federation that the maximum price of coals for industrial purposes, factories &c., should be 30s. per ton delivered, including the cost of railway carriage, and that the Government should make up the difference to the coalowners is a very plausible and apparently simple plan. According to the secretary of the Miners' Federation, in six months' time, under the working of such a scheme, the industry would have experienced such a revival that it would be well on its feet. It is very doubtful whether such expectations would be realised, and it is fairly certain that six months' operation of such a scheme would entail upon the country a cost of considerably more than eight million pounds. The fact, of course, is that the miners are doing their utmost to avoid wages coming down to the economic level. They know that, for November, wages will be down practically to the minimum established under the national agreement and that they will be so low as to arouse a good deal of hostility among the rank and file. At the same time the predominant view is that for wages to be maintained at an artificial level by means of a State subsidy is wholly unsound. The industry should pay what it can afford. The position of many collieries now is very serious, as they are already working on bank overdrafts. Following a three months' stoppage they have worked for three months and retained no profits; in fact, they have and are now sustaining losses at the prices at which coals are being sold. Collieries have been unable to set aside any money, as was the case hitherto, for developments, and this in itself is a serious matter in relation to the provision of future employment for workmen.

Dissatisfied Miners.

The present plight in which the mining industry finds itself and the vast amount of unemployment and low wages prevailing has naturally created a good deal of grumbling among the rank and file, and responsibility for the pass to which things have come is being saddled on the leaders. The Cwm Colliery Lodge at Llantwit Fardre, which has recently undergone reconstruction, has come out into the open with an attack upon the Federation, and in manifesto form has made an appeal to the miners of South Wales for support of their scheme, which is aimed at the reconstitution of the South Wales Federation. The signatories contend that the existing organisation has practically ceased to function, and express the hope that the members of other lodges will take the matter up seriously and combine to form a trade union which will prove to be at least more stable than the "sorry wreck now in existence." They then set out the rules they propose, which include a monthly contribution of 2s. per member; that no official shall receive a higher rate of wages than the maximum rate of wages plus current percentages paid to a collier in the particular official's district; that any member seeking election to Parliament, to a county or district council, or taking up any similar public work, shall resign his position in the lodge, and that every official be put up for re-election once every two years. The signatories to the manifesto invite consideration and criticism of their scheme, and naturally it has brought a reply. The general secretary of the South Wales Miners' Federation states that some of them have spent a lifetime in the endeavour to build up an organisation that will secure equitable conditions for the members of the Federation, and they say, too, that their scheme is not perfect, but that it is a million times better than that which "these amateurs" are foreshadowing.

Coal Output.

During the past week or so trouble has arisen at several collieries on account of the fact that the owners and managements are not satisfied with the quantity of coal being produced, inasmuch as supplies have fallen appreciably compared with what was being produced a month or so ago. A case in point is that of the Cardiff Collieries, Limited, which gave notices recently to the men of the intention of the owners to close down the Llanbradach colliery, which employs 2000 men, if the output was not increased. Interviews between the miners' agent and the management have taken place, when the latter made it clear that the company was not asking the men to do something they had not done. The company has not been getting the August output, but if it is restored and maintained, then it is probable that the collieries will be kept working.

Dean Forest Developments.

Notices have been posted up at the collieries owned by Messrs. Henry Crawshay and Co., Dean Forest, that in future the pits in question will be open to the present employees on the basis of the wages prevailing in the district. After payment of such wages, any profits in excess of 10 per cent. of the capital of the company will be divided in equal proportion between the workmen and the shareholders until further notice. Messrs. Crawshay and Co. have withdrawn from the Mining Association and the District Board. The workmen have held a mass meeting and decided to go to work under protest, but a ballot is to be taken on the question of acceptance or rejection of the owners' ultimatum. The company has declared that rather than be forced to the Government audit and the national settlement it would close down. On the other hand, the workmen, in considering whether they shall accept or reject the owners' terms, are faced with the fact that there are no Federation or local funds on which they can rely to support them in the event of their refusing to work.

Railway and Dock Charges.

The movement for bringing about, if possible, a reduction in railway and dock charges is progressing very satisfactorily. There is a commendable eagerness on the part of all the sections of the trading community affected to co-operate, and thus by united action submit a case which is unanswerable. The action taken by the Cardiff Chamber of Commerce is receiving support in all quarters, and a special meeting of all the interests concerned is to be held to-day, to discuss the position and act together. As announced, the Great Western Railway Company has given a very sympathetic hearing to the case of the coalowners, but apart from this it is apparent that traders are looking to the Barry Railway Company for a lead in the direction of reduced charges. It will be recollected that the Barry company opposed the Grouping Bill, and although it is a constituent company in the Welsh group, nevertheless it cannot be forced into the group until 1923. It is noteworthy that the Barry company has withdrawn from the Bristol Channel Dockowners' Association, and from this the conclusion is drawn that it is its' intention to adopt a course of action more in the interests of the trading community. The belief is confidently entertained that the company will before long announce material reductions in traffic rates and dock charges which will create great satisfaction in commercial circles, and which will have the effect of compelling other railway and dock companies to adopt similar action. So far the labour unions have not displayed any readiness to co-operate with traders, and this fact is much regretted, as success in the movement is all to the advantage of the workers in promoting business and remedying unemployment.

Steel and Tin-plate Items.

It is understood that a meeting is being arranged between the workmen and the employers in the tin-plate trade regarding the effect of the sliding scale agreement respecting steel bar prices on tin-platers' wages. The announcement is made that the Eagle Tin-plate Works, Neath, have been purchased by Baldwins, Limited, the purchase price being given as in the neighbourhood of £30,000. Additional furnaces have been re-started at the steel works at Llanelly, and operations have been partially resumed at several tin-plate works.

Current Business.

The coal market displays no new feature, and the conditions are quiet all round, with prices of steam coals on the easy side. The demand from abroad is very limited, and the utmost difficulty is experienced in getting sufficient orders to absorb present outputs of large coals. No improvement is looked for for some time to come. Small coals are firm owing to the irregular working of pits, and the scarcity of leading grades, while coke is weaker at 50s. to 55s. Patent fuel remains at from 28s. to 30s. Anthracite coals are firm owing to the colder weather stimulating a demand, and collieries are well booked up already for November, especially as regards sized coals and best large.

Latest News from the Provinces.

LANCASHIRE.

MANCHESTER.

The State of Employment and Relief Works.

According to the latest returns for Lancashire and Cheshire issued by the divisional department of the Ministry of Labour in Manchester, there has recently been some slight improvement in industrial conditions. During last week 15,739 persons passed from the books of the employment exchanges into the ranks of the employed, leaving still over 213,000 out of work, of whom 164,330 are males, while there are also about 62,000 persons on short time. Only about one-half of the total number are now receiving unemployment pay, the remainder having exhausted their twenty-two weeks' allowance. Whatever improvement the figures show is chiefly due to a slight revival in the textile industries. I regret to state that there is as yet no sign of improvement in the engineering trades, and even in the building trade there are more "hands" available than can be found work for. The wages paid in the mining industry continue to decline. The District Joint Wages Board for Lancashire, Cheshire and North Staffordshire has announced another drop of 4d. per day for October, namely, at the rate of 111 per cent. on the basis rate of 1911. The fall in wages since the great coal strike up to date amounts to 3s. per day for adults and half this amount for youths. In the meantime the special committee of the Manchester Corporation to deal with unemployment recommends the City Council to proceed with eleven of the fifteen undertakings which the committee was instructed to consider. These include the completion of the Heaton Park reservoir, the reconstruction of main roads, and the building of schools. The expenditure on the reservoir will amount to £300,000 and £80,000 for main roads, and borrowing powers will have to be obtained for £373,500 for the construction of town-planning roads. Ratepayers are groaning under the recent increases. The total rate in the pound is now 15s. on an increased rateable value of nearly 50 per cent. compared with 1913–14.

SHEFFIELD.

The Defiatory Movement.

The prices of some of the ferro-alloys have been further reduced, as will be found noted on the Current Prices page, and soft wire rods are now quoted at an even £12. Derbyshire No. 3 foundry pig iron has been sold down to £5 15s. at the furnaces and even a trifle lower. Quite a striking deflation is going on in nearly all sections of the iron and steel trade; in fact, prices are now so low that it is evident the meaning is that makers are basing them on the prospect of a further fall in the costs of production, there being thus a good deal of speculation in the movement as well as a determination to get business if by any means possible. There is increasing evidence of business to be placed if only prices are right, for more genuine inquiries are coming in than for some time, many of them having all the probabilities of materialising into orders. This applies to the greatest extent to the Far East.

WALES AND ADJOINING COUNTIES.

Spelter Industry.

Although the Board of Trade has announced that it has instructed its agents in Australia to ship a supply of Broken Hill zinc concentrates to this country, it is reported that no definite offer has been received at Swansea by firms interested. So far as the spelter trade is concerned, the question primarily to be faced is that of costs of production. A meeting of employers and workmen is likely to be held shortly to discuss the question of wages.

Railway and Dock Charges.

It is interesting to note that the Barry Railway Company has reduced its wharf and warehouse rents by from 5 to 10 per cent., and in some instances more, these reductions dating back to October 10th. This is a beginning, and it is hoped that other railway and dock charges will receive attention, to the advantage of the coal trade generally.

Swansea Metal Exchange.

The tone prevailing in the steel and tin-plate trades is a little more cheerful, and prices are slightly firmer. So far as the tin-plate trade is concerned, costs are getting nearer to selling prices. The galvanised sheet market is also rather more active, additional mills having been re-started.

A MAP of the chief sources of metals in the British Empire, with diagrams of production for 1918 has been prepared under the direction of the Mineral Resources Committee of the Imperial Institute. It is a new edition, much amplified, of a similar map issued by the Institute in 1918, and consists of three sections, a general map of the world on Mercator's projection, a series of inset maps of British countries and a separate set of diagrams of metal production. The inset maps are all drawn to a uniform scale of 160 miles to the inch. The map measures 35½in. by 44in., and is procurable from the Imperial Institute or from Geo. Philip and Sons, Limited.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	37/-
[1] Spanish	28/-
[1] N. African	28/-
N.E. Coast—	
Native	—
Foreign (c.i.f.)	27/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—[2]		
Hematite	7 5 0	—
No. 1 Foundry	7 5 0	—
No. 3 ,,	7 0 0	—
N.E. Coast—		
Hematite Mixed Nos.	6 5 0	6 5 0
No. 1	6 7 6	6 7 6
Cleveland—		
No. 1	6 5 0	6 10 0
Silicious Iron	—	—
No. 3 G.M.B.	6 0 0	6 5 0
No. 4 Foundry	5 19 0	5 19 0
No. 4 Forge	5 12 6	5 12 6
Mottled	5 10 0	5 10 0
White	5 10 0	5 10 0
Midlands.		
Staffs.—		
All-mine (Cold Blast)	17 0 0 to 17 7 6	
Part Mine Forge	*None offering.*	
,, Foundry No. 3	*None offering.*	
Northampton—[4]		
Foundry Nos. 2 and 1	*Nominal.*	
,, No. 3	5 15 0 to 6 0 0	
,, Forge	5 5 0	—
Derbyshire—[2]		
No. 3 Foundry	5 15 0 to 6 0 0	
Forge	5 5 0 to 5 10 0	
Lincolnshire—		
Basic	*Uncertain.*	
Foundry	,,	
Forge	,,	
N.W. Coast—[4]		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	7 5 0	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	14 0 0	—
Best ,,	17 0 0	—
N.E. Coast—		
Common Bars	14 0 0	—
Marked ,,	18 0 0	—
Tees	14 10 0	—
Lancs.—		
Crown Bars	14 0 0	—
Hoops	17 5 0	17 0 0
S. Yorks.—		
Crown Bars	14 10 0	—
Best ,,	17 0 0	—
Hoops	17 5 0	—
Midlands—		
Marked Bars (Staffs.)	17 10 0	—
Crown Bars	14 10 0	—
Nut and Bolt Bars	14 10 0	—
Gas Tube Strip	15 0 0	—
Hoops	17 10 0 to 20 0 0	

STEEL.

	Home.[4] £ s. d.	Export.[7] £ s. d.
Scotland—[5]		
Boiler Plates	16 0 0	—
Ship Plates ¾in. and up	12 10 0	—
Sections	12 0 0	—
Steel Sheets ⅛in. to ¾in.	13 15 0	—
Sheets (Gal. Cor. 24 B.G.)	—	22 0 0
N.E. Coast—		
Ship Plates	10 10 0	—
Angles	10 0 0	—
Boiler Plates	16 0 0	—
Joists	10 0 0	—
Heavy Rails	10 10 0	—
Fish-plates	15 10 0	—
Channels	14 10 0	—
Hard Billets	11 0 0	—
Soft Billets	9 10 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	11 0 0	—
Light ,,	13 0 0 to 15 0 0	
Billets	10 0 0	—
Ship Plates	10 10 0	—
Boiler ,,	16 0 0	—
Manchester (*Prices irregular and uncertain, unchanged*)—		
[8] Bars (Round)	10 0 0 to 12 0 0	
[8] ,, (others)	11 0 0 to 12 0 0	
Hoops (Best)	17 5 0	17 0 0
,, (Soft Steel)	14 5 0	14 0 0
Plates	£10 to 12	10 0 0
,, (Lancs. Boiler)	16 0 0	
Sheffield—		
Siemens Acid Billets	14 10 0	—
Bessemer Billets	14 0 0	—
Hard Basic ,,	10 0 0	—
Soft ,,	8 10 0 to 10 0 0	
Hoops	14 5 0	—
Soft Wire Rods	12 0 0	—
Midlands—		
Small Rolled Bars	11 0 0 to 12 0 0	
Bessemer Billets and Sheet Bars	7 15 0 to 8 5 0	
[2] Hoops	13 10 0	—
Tube Strip	11 10 0	—
Sheets (24 W.G.)	16 0 0	—
Galv. Sheets (f.o.b. L'pool)	18 10 0 to 20 0 0	
Angles	10 0 0	—
Joists	10 10 0	—
Tees	11 0 0	—
Bridge and Tank Plates	10 10 0	—

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	21/- to 22/6
Block Tin (cash)	158 5 0
,, (three months)	160 10 0
Copper (cash)	66 0 0
,, (three months)	67 2 6
Spanish Lead (cash)	24 0 0
,, (three months)	23 15 0
Spelter (cash)	26 7 6
,, (three months)	26 15 0
Manchester—	
[9] Copper, Best Selected Ingots	68 0 0
,, Electrolytic	73 0 0
[10] ,, Strong Sheets	101 0 0
,, Loco Tubes	0 1 2½
Brass Loco Tubes	0 1 0½
,, Condenser	0 1 4½
Lead, English	25 0 0
,, Foreign	24 0 0

(*Metal prices practically unchanged*).

FERRO ALLOYS.

(*All prices now nominal*).

	Per Ton.	Per Unit
Tungsten Metal Powder	1/8 per lb.	
Ferro Tungsten	1/6 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£28	12/-
,, 6 p.c. to 8 p.c. ,,	£26	10/-
,, 8 p.c. to 10 p.c. ,,	£26	10/-
,, Specially Refined		
Max. 2 p.c. carbon	£79	28/-
,, 1 p.c. ,,	£94	32/-
,, 0·75 p.c. carbon	£110	41/-
,, carbon free	2/8 per lb.	
Metallic Chromium	5/6 per lb.	
Ferro Manganese	(per ton) £18 for home.	
,, Silicon, 45 p.c. to 50 p.c.	£12 10 0 scale 5/- per unit	
,, 75 p.c.	£20 0 0 scale 6/- per unit	
,, Vanadium	21/- per lb.	
,, Molybdenum	9/- per lb.	
,, Titanium (carbon free)	1/6 per lb.	
Nickel (per ton)	£190	
Cobalt	14/6 per lb.	
Aluminium (per ton)	£110 to £120 (British Officials).	

FUELS.

	Export.
SCOTLAND.	
Lanarkshire—	
(f.o.b. Glasgow)—Steam	26/-
,, ,, Ell	27/6
,, ,, Splint	28/6 to 30/-
,, ,, Trebles	27/-
,, ,, Doubles	25/-
,, ,, Singles	20/-
Ayrshire—	
(f.o.b. Ports)—Steam	26/-
,, ,, Splint	28/6
,, ,, Trebles	27/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	20/6 to 24/6
Screened Navigation	31/-
Trebles	28/6
Doubles	23/-
Singles	20/-
Lothians—	
(f.o.b. Leith)—Best Steam	24/-
Secondary Steam	23/6
Trebles	27/6
Doubles	25/6
Singles	20/-
ENGLAND.	
[11] N.W. Coast—	
Steams	38/-
Household	40/- to 55/-
Coke	37/6 to 42/6
Northumberland—	
Best Steams	27/- to 27/6
Second Steams	24/- to 25/-
Steam Smalls[6]	17/6
Unscreened	22/6 to 27/-
Household	30/- to 35/-
Durham—	
Best Gas	26/-
Second ,,	22/- to 24/-
Household ,,	30/- to 35/-
Foundry Coke	40/- to 42/6
Sheffield—[11]	
S. Yorks. Best Steam Hards	32/- to 33/-
Derbyshire Hards	31/6 to 32/-
Seconds	30/6 to 31/6
Cobbles	30/6 to 31/6
Nuts	28/- to 30/-
Washed Smalls	17/- to 18/-
Best Hard Slacks	17/6 to 18/6
Seconds ,,	17/- to 17/6
Soft Nutty ,,	17/- to 17/6
Pea ,,	11/6 to 12/6
Small ,,	9/- to 10/-
House, Branch	40/- to 41/-
,, Best Silkstone	37/6 to 39/-
Blast Furnace Coke (Inland and Export)	25/- to 30/-
Cardiff—[12] SOUTH WALES.	
Steam Coals:	
Best Smokeless Large	28/6 to 29/6
Second ,, ,,	28/- to 28/6
Best Dry Large	28/- to 29/-
Ordinary Dry Large	27/6 to 28/-
Best Black Vein Large	27/6 to 28/6
Western Valley ,,	27/- to 28/-
Best Eastern Valley Large	26/- to 27/-
Ordinary ,, ,,	25/- to 26/-
Best Steam Smalls	19/6 to 20/-
Ordinary ,,	12/6 to 18/-
Washed Nuts	30/- to 35/-
No. 3 Rhondda Large	30/- to 32/6
,, ,, Smalls	18/- to 20/-
No. 2 ,, Large	25/- to 26/-
,, ,, Through	20/- to 22/6
,, ,, Smalls	15/- to 16/-
Coke (export)	50/- to 55/-
Patent Fuel	28/- to 30/-
Pitwood (ex ship)	37/6 to 40/-
Swansea—	
Anthracite Coals:	
Best Large	55/- to 57/6
Seconds	52/6 to 55/-
Red Vein	47/6 to 50/-
Big Vein	55/- to 57/6
Machine-made Cobbles	70/- to 72/6
Nuts	72/6 to 75/-
Beans	60/- to 62/6
Peas	30/- to 32/6
Breaker Duff	8/6 to 9/-
Rubbly Culm	12/6 to 13/-
Steam Coals:	
Large	28/- to 30/-
Seconds	27/- to 28/-
Smalls	12/6 to 16/-
Cargo Through	22/6 to 25/-

[1] Delivered. [2] Net Makers' works. [3] At furnaces. [4] Delivered Sheffield. [5] Glasgow, Lanarkshire and Ayrshire. [6] Home Prices—All delivered Glasgow Station.
[7] Export Prices—F.O.B. Glasgow. [8] Prices represent the real market before the *official* change was made. [9] These prices are practically alike now.
[10] Sheets reduced while other prices are advancing. [11] Except where otherwise indicated coals are per ton at pit for inland and f.o.b. for export and coke is per ton on rail at ovens and f.o.b. for export.
[12] For inland sales. [13] Per ton f.o.b.

French Engineering Notes.

(From our Correspondent in Paris.)

Tractors.

The autumn demonstration of ploughing tractors held last week at Le Bourget, near Paris, helped to revive interest in mechanical tillage, but it did not do much to assist the tractor industry, which has been laying under a cloud for a long while past. Those who are able to use such vehicles need information that was not provided by the demonstration. It simply served to enable manufacturers to show their machines in operation on the field, but there were no tests of efficiency or consumption, and nothing to guide agriculturists in the selection of tractors. Nevertheless, the machines, on a field of so large an area that it took quite a long time to explore, represented practically all the types of motor ploughing vehicles, although with one exception there was an entire absence of anything that would suggest a possible new development in the tractor industry. The agriculturist is still interested in the farm vehicle, but his lack of practical support is somewhat disconcerting to makers, who have begun to see that the problem is more complicated than they had supposed, and, as everything depends upon the exact cost of motor ploughing, the factor of upkeep entering into the calculations is at present an imperfectly known quantity. Until, therefore, the farmer can be guaranteed against surprises in the way of unforeseen expenses or of losses from breakdowns, the only satisfactory means of carrying on tillage operations with tractors is through co-operative associations or private contractors, who are able to run the machines economically and are thereby doing valuable work in popularising the tractor. Nearly all the business is done through these associations or with large estate owners who employ skilled hands capable of keeping the machines in good running order. The average farmer will scarcely venture to purchase a tractor until he is satisfied that he can rely upon the makers' service to maintain it in good condition for a certain number of years.

Motor Ploughs.

Of the many systems of mechanical tillage shown at Le Bourget there are two that continue to fulfil definite requirements, the medium-powered tractor of the Austin and Fiat types and the motor plough. The heavy tractors that have been introduced from time to time for deep ploughing have failed on account of low efficiency due to so much power being required to move the vehicles, and at Le Bourget the only systems suitable for tilling to depths of more than 6in. were the cable sets and the motor ploughs, these latter machines being mainly a development of the German Stock plough, which before the war gave by far the best results in France so far as concerned the weight of soil displaced. The two motor ploughs of this type in operation were of Czeko-Slovakian manufacture, and in each case the chassis was balanced on two wheels of about 6ft. diameter, with the engines of 35 or 40 horse-power at one end and the rigid ploughs with the driver's seat at the other. On account of their length and height they appear cumbrous, but they were easily handled, and with three or four shares they ploughed to a depth of 11in. to 12in. in extremely hard and dry soil. Equally good results were obtained with the Delahaye "Tournesol" plough, which is on an entirely different principle, with the chassis supported on big driving wheels and two smaller steering wheels and the ploughs at each end articulated under the chassis. These results are due to direct gearing down on large diameter wheels, and to the more effective utilisation of power on the implement. Motor ploughs of these types are evidently only suitable for large farms, where they can find sufficient employment for deep tillage, although some of them are adapted for general farm work, for which they are presumably not so convenient or economical as the ordinary tractor. The cable systems were represented by the De Dion-Bouton and the Société Electro-Mécanique, the latter consisting of a vehicle with electrically driven drums from which the cables pass round anchored pulleys to the plough that is drawn backwards and forwards across the field. It must be admitted that as regards the weight of soil turned in a given time, and the appearance of the furrows the results were not so good as with the heavy motor ploughs. Nevertheless, it is probable that cable ploughing would show up to better advantage if the implement were handled by a farm labourer instead of by a mechanic. In a general way, it may be concluded that the French tractor industry is in much the same position as it was a year ago, although it is holding its own against the American tractors, which were in strong force on the demonstration ground.

Paris Water Supply.

A Commission of the Paris Municipality has recently visited the Vals de Loire to investigate the results of the research work carried out during the past eighteen months with a view of ascertaining the possibility of drawing upon the subterranean supplies of water. This water lies at a depth of from 6 m. to 10 m. between Briare and Nevers over a distance of 80 kiloms. and a width of 3 kiloms. Pumping operations before the war proved that the water was of good quality, and they have been continued during the past two years, partly in order to ascertain if the level were likely to be reduced by the raising of such large quantities of water. The local authorities have been protesting strongly against the proposed diversion of the water to Paris, on the ground that indications pointed to the probability of the supplies becoming exhausted; but the Paris Commission has been able to prove that there is no such danger, and that, moreover, the construction of a barrage to hold up the water would permit of the level of the Loire being maintained in summer and winter, while it would at the same time provide electrical energy for local uses. It is proposed to raise the water 10 m., carry it across the Loire to a reservoir above Briare and then convey it to Paris by gravitation by an aqueduct 175 kiloms. long. It is intended to divert 500,000 cubic metres—say, 110,000,000 gallons—a day, but provision will be made for double that quantity in the future.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

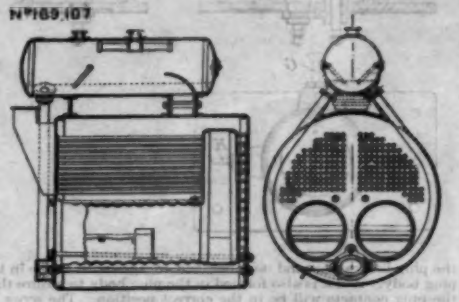
The date first given is the date of application; the second date at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

169,107. October 7th, 1920.—Return Tube Boilers, D. W. Robb, 7209, Euclid-avenue, Cleveland, Ohio.

The inventor desires to improve the circulation of the water in return-tube boilers, and for this purpose mounts a drum above. The drum is connected with the top of the boiler by a

N°169,107



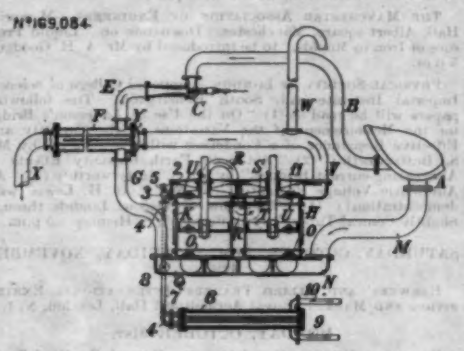
large neck, above which a deflecting plate is arranged, and with the bottom of the boiler by two downcomers. The water level is, presumably, at the dotted line in the drawings.—*September 22nd*, 1921.

CONDENSERS AND FEED-WATER HEATERS.

169,084. August 12th, 1920.—Condensing Steam and Heating Feed Water, G. and J. Weir, Limited, Cathcart, Glasgow, and C. J. Lang.

This air pump is of the "Weir dual" type. H is the "wet" pump barrel and K the "dry" pump barrel. The water of condensation passes from the main condenser A through the conduit M to the chamber N situated below the foot valves O of the "wet" barrel. The air with condensate—formed by the condensation within the supplementary condenser—leaves the latter by the duct G which conducts it to the chamber Q situated below the foot valves O of the "dry" barrel. The air, after being compressed in the "dry" barrel, is discharged from the chamber 2, situated above the head valves U of the latter, through the pipe R into the "wet" barrel, entering the latter by way of the port S situated above the piston T, but below the head valves U. The water and air are discharged from the chamber 11 situated above the head valves U of the "wet" pump barrel through the pipe V, the air escaping to the

N°169,084



atmosphere through the air relief pipe W while the water passes into the water box or header Y of the supplementary condenser, passes through the tubes of this condenser, and is discharged from the condenser by the pipe X into the feed system between the air pump and the boiler. Should the condensate discharge from the supplementary condenser be inadequate as regards quantity or coolness for the needs of the "dry" pump barrel, a circulating water cooler arrangement, as has been heretofore employed with "Weir dual" air pumps, may be provided. Such an arrangement is shown on the drawing. A certain amount of water is drawn from the chamber 2 situated above the head valves U of the "dry" barrel. This water leaves the chamber by the port 3 and passes down through the pipe 4, controlled by the valve 5, to the cooler 6, thereafter ascending by the pipe 7 and entering by the port 8 the chamber Q situated below the foot valves of the "dry" pump barrel. The cooling water for the cooler, which may be drawn from any convenient source, is delivered to the cooler by the pipe 9 and leaves the cooler by the pipe 10.—*September 22nd*, 1921.

WIRELESS TELEGRAPHY.

147,699. July 9th, 1920.—Improvements in Wave Telephone Systems, Gesellschaft fur Drahtlose Telegraphie, M.B.H., 9, Tempelhofer Ufer, Berlin, Germany.

In systems of telephony utilising high frequency oscillations

N°147,699

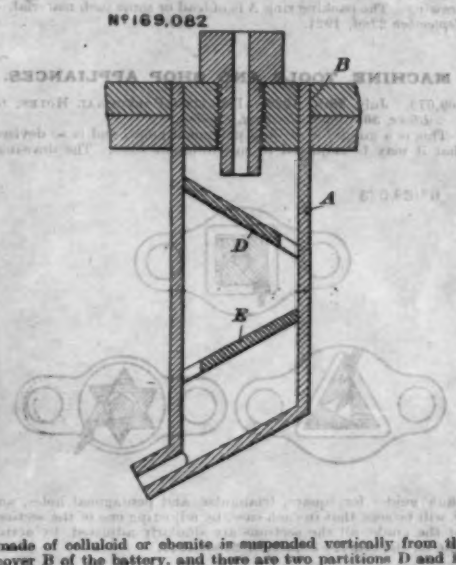
in line wires both the transmitter and receiver have hitherto been inductively coupled to a line wire. In such cases the receiver is apt to be damaged either by the direct influence of the leakage field of the adjacent transmitter or indirectly through the coupling with the line wire. According to this invention a mutual coupling is provided between the transmitter and the receiver, and the effect upon the receiver of this coupling counterbalances the normal effect and so prevents the occurrence of damage. In the diagram a transmitter S and a receiver E are arranged near together at a wave telephone station. Both instruments are connected in the usual manner by the coupling transformers A and B to the line wire C, to which other stations are connected at D. In order that the receiver E shall not be injuriously influenced by the transmitter S the transmitters and receiver E are inductively coupled together by windings F and G. The strength of the coupling and the direction of the windings are so chosen that the action of the auxiliary coupling is opposite to the injurious action of the transmitter and wholly or partially neutralises it.—*September 22nd*, 1921.

BATTERIES.

169,082. August 9th, 1920.—Improvements in or connected with Gas Exits for Galvanic Batteries, Orlando Oldham, of Oldham and Son, George Oldham, and John Oldham, all of Hyde-road, Denton, near Manchester.

This invention has for its object to provide a device to allow of the free escape of gas and air from batteries and to prevent the escape or spilling of acid or liquid. A tube or chamber A

N°169,082



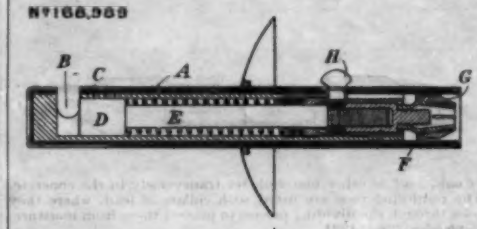
made of celluloid or ebonite is suspended vertically from the cover B of the battery, and there are two partitions D and E, arranged as shown.—*September 22nd*, 1921.

ELECTRIC WELDING.

168,989. June 11th, 1920.—Handle for Electric Arc Welding, John Dorley, 65, Strand-road, Bootle, Liverpool.

The outer part of the handle A is composed of ebonite or vulcanised fibre, and is slotted at B for the reception of the carbon or other electrode. Inside the tube is a metal sleeve C and a sliding piston D, which is acted upon by a spring that causes the head of the piston to hold the electrode in position. The rear end of the piston-rod E is screwed to receive a nipple

N°168,989



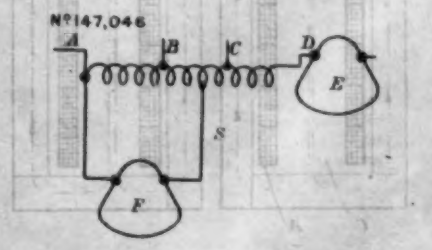
on which is screwed a clamp F in the form of a chuck for the electric conductor. The chuck is tightened by screwing up the outer sleeve G. A knob H passes through a slot in the tube A and sleeve C and is screwed into the spindle E so that the plunger D can be drawn back against the spring when it is desired to release the electrode in the slot B or to connect up the conductor at G.—*September 12th*, 1920.

TESTING AND MEASURING INSTRUMENTS.

147,046. June 30th, 1919.—Improvements in or relating to Testing Sets, including Electric Current Transformers for Use with Measuring Instruments, Compagnie pour la Fabrication des Compteurs et Materiel d'Usines a Gaz, of 16 and 18, Boulevard de Vaugirard, Paris, France.

This invention relates to testing sets for calibrating measuring electric instruments. A variable ratio is obtained by an adjustable auto transformer, and only one standard instrument is

N°147,046



required, thereby obviating the need of a standard instrument for every different range of values to be measured. A is one of the end terminals of the transformer, and B, C, D are the three intermediate terminals. S is the other end terminal of the

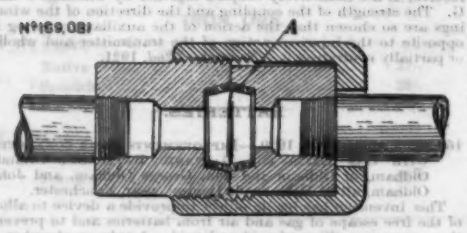
transformer, E is the standard instrument, and F is the measuring instrument to be calibrated. The principle is obvious.—*September 22nd*, 1921.

TRANSMISSION OF POWER.

169,081. August 4th, 1920.—Pipe Couplings, the British Thomson-Houston Company, Limited, 83, Cannon-street, London, E.C. 4.

This pipe coupling is intended to withstand pressures up to

N°169,081



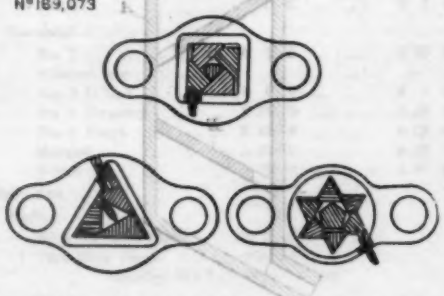
6000 lb. per square inch. The construction is obvious from the drawing. The packing ring A is of lead or some such material.—*September 22nd*, 1921.

MACHINE TOOLS AND SHOP APPLIANCES.

169,073. July 28th, 1920.—Drilling Polygonal Holes, *G. Blake*, 36, *Camomile-street, London.*

This is a guide for drilling polygonal holes, and is so devised that it may be adjusted to suit different sizes. The drawings

N°169,073



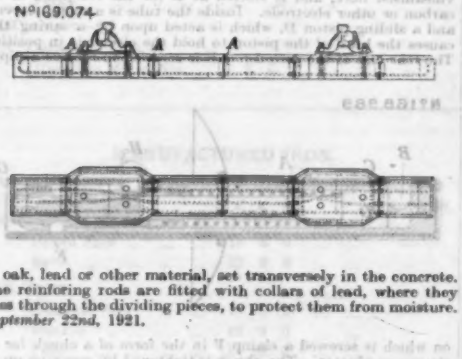
show guides for square, triangular and pentagonal holes, and it will be seen that in each case, by adjusting one of the sections of the guide, all the sections are similarly adjusted, by acting one on the other.—*September 22nd*, 1921.

TRAMWAYS AND RAILWAYS.

169,074. July 29th, 1920.—Concrete Sleepers, A. Wood-Hill, Byron-hill, Harrow.

The inventor proposes to provide a certain degree of resilience in reinforced concrete sleepers by employing dividing pieces A,

N°169,074



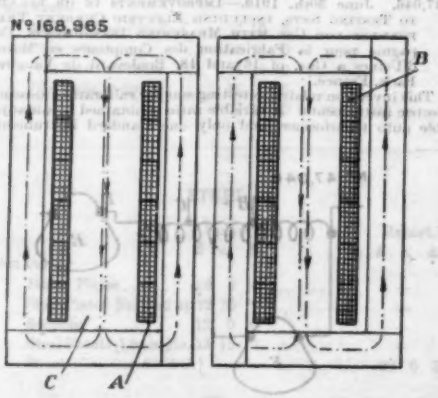
of oak, lead or other material, set transversely in the concrete. The reinforing rods are fitted with collars of lead, where they pass through the dividing pieces, to protect them from moisture. *September 22nd*, 1921.

MISCELLANEOUS.

168,965. June 4th, 1920.—Improvements in or relating to Reactance or Choke Coils, Frederick Edmund Berry, of the British Electric Transformer Company's Works, Hayes, Middlesex.

The object of this invention is to provide a reactance or choke coil which has no stray fields and the iron circuit of which has a uniform induction throughout. Two coils *A* and *B* of different

N°168,965

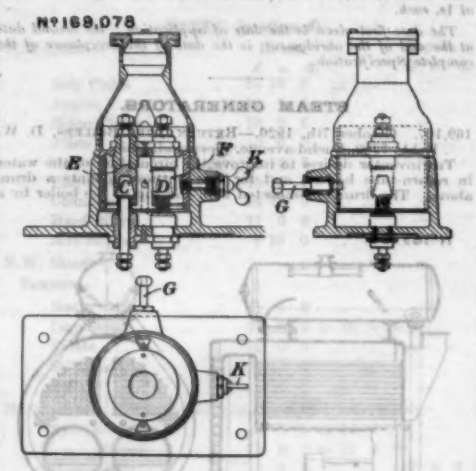


diameter are arranged concentrically one within the other so as to leave an air space *C* between them, and the whole entirely enclosed by an iron circuit that extends also through the central and smaller coil. The magnetic fluxes produced by the coils oppose one another in the iron circuit but combine in the air space between the coils.—*February 5th*, 1921.

169,878. April 28th, 1921.—Improvements in and relating to Electrical Current Plugs, William De Renzi, of the Hamilton Engineering Company, Muir-street, Hamilton, Lanarkshire.

The contacts C and D are tapered as shown, and are forced upwards by special springs. The plug sockets E and F fit over the contacts C and D. To keep the plug in position when it is pushed home a catch is provided. A spindle G passes through

N°169,078



the plug box casing, and its inner end engages with a hole in the plug body. A slot is also formed in the plug body to ensure that the plug contacts will be in the correct position. The screw K is for making the earth connection.—*September 22nd*, 1921.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

Institution of Mechanical Engineers.—Storey's-gate, S.W. 1. Discussion on the Eleventh Alloys Report to be resumed. 6 p.m.

Junior Institution of Engineers.—Caxton Hall, Westminster, S.W. 1. Lecturette, "Water-gas Manufacture," by Mr. F. Colin Sutton. 8 p.m.

The Association of Engineering and Shipbuilding Draughtsmen: Merseyside Branch.—University Engineering Building, Liverpool. "The Age of the Earth," by Professor P. G. H. Boswell. Illustrated. 7.30 p.m.

The Manchester Association of Engineers.—Memorial Hall, Albert-square, Manchester. Discussion on "Liquid Pressure of Iron in Moulds," to be introduced by Mr. A. H. Goodger. 7 p.m.

Physical Society of London.—Imperial College of Science, Imperial Institute-road, South Kensington. The following papers will be read:—(1) "On the Use of Anderson's Bridge for the Measurement of the Variations of the Capacity and Effective Resistance of a Condenser with Frequency," by Mr. S. Butterworth; (2) "Notes on Earth Capacity Effects in Alternating-current Bridges," by Mr. S. Butterworth; (3) "An Automatic Voltage Regulator," by Mr. F. G. H. Lewis (with demonstration); (4) "The Flow of Viscous Liquids through Slightly Conical Tubes," by Professor A. S. Hemmy. 5 p.m.

SATURDAY, OCTOBER 29TH, TO FRIDAY, NOVEMBER 4TH.

Brewers' and Allied Traders' International Exhibition and Market, Royal Agricultural Hall, London, N. 1.

MONDAY, OCTOBER 31ST.

Bradford Engineering Society.—City of Bradford Technical College. "Michell Bearings," by Mr. H. T. Newbigin. 7.30 p.m.

TUESDAY, NOVEMBER 1ST.

Institution of Civil Engineers.—Great George-street, S.W. 1. Presidential address by Mr. William Barton Worthington. 6 p.m.

Institute of Marine Engineers.—The Minories, Tower-hill, E. Presidential address. 6.30 p.m.

WEDNESDAY, NOVEMBER 2ND.

Industrial League and Council.—Caxton Hall, S.W. Lecture on "Ability as a Factor in the Production of Wealth," by Mr. E. C. de Segundo. 7.30 p.m.

Institution of Railway Signal Engineers.—Midland Grand Hotel, St. Pancras. Paper: "Three-position Signalling," by Mr. A. E. Tattersall. 6 p.m.

Liverpool Engineering Society.—Royal Institution, Colquitt-street, Liverpool. Presidential address by Mr. J. B. Wilkie. 8 p.m.

Royal Society of Arts.—John-street, Adelphi, W.C. 2. "Wireless Telegraphy," by Mr. Alan A. Campbell Swinton (illustrated by experiments). 8 p.m.

Société des Ingenieurs Civils de France.—Institution of Mechanical Engineers, Storey's-gate, S.W. 1. Paper: "The Efforts of France in the Reconstruction of the Devastated Regions," by the Marquis de Chasseloup-Laubat. 5.30 p.m.

Thornycroft Engineering Society.—Works Canteen, Basingstoke. Informal meeting for general discussion. 7 p.m.

THURSDAY, NOVEMBER 3RD.

Institution of Electrical Engineers.—Savoy-place, Victoria Embankment, W.C. 2. Presidential address by Mr. J. S. Highfield. 6 p.m.

East London College: Department of Civil and Mechanical Engineering.—Mile End-road, E. 1. Lecture II. on "Diesel and Semi-Diesel Oil Engines, the Present Position of the Heavy Oil Engine and the Problems involved in its Further Development," by Engineer-Commander B. W. Knott. 6 p.m.

Manchester Association of Engineers: Students Section.—Chemical Lecture Theatre, Municipal College of Technology, Manchester. Lecture: "Metals," by Mr. W. E. W. Millington. 7 p.m.

Royal Aeronautical Society.—Royal Society of Arts, John-street, Adelphi. "The Manœuvres of Getting Off and Landing," by Squadron-Leader R. M. Hill. 5.30 p.m.

FRIDAY, NOVEMBER 4TH.

Institution of Mechanical Engineers.—Storey's-gate, St. James' Park, S.W. 1. Thomas Hawksley Lecture on "Power Transmission by Oil," by Dr. H. S. Hele-Shaw. 6 p.m.

The Junior Institution of Engineers.—Caxton Hall, Westminster, S.W. 1. "Timber Trees of Commerce," by Mr. T. H. Ivey. 8 p.m.

Association of Engineering and Shipbuilding Draughtsmen: Merseyside Branch.—Walker Engineering Lecture Theatre, University of Liverpool. Lecture: "Peace or War?" by Major C. H. Douglas. 7.30 p.m.

North-East Coast Institution of Engineers and Shipbuilders.—Literary and Philosophical Society, Westgate-road, Newcastle-on-Tyne. "Sea Casualties and Losses of Life," by Sir Westcott S. Abell. 6.30 p.m.

SATURDAY, NOVEMBER 5TH.

The Institution of British Foundrymen: Lancashire Branch.—College of Technology, Manchester. "The New White Metal Series, with special reference to Magnesium and its Future Use in Aircraft and Textile Machinery," by Mr. J. D. Paton. 4 p.m.

MONDAY, NOVEMBER 7TH.

Institution of Locomotive Engineers.—Y.M.C.A., Albion-street, Leeds. Paper: "Notes on Axle-boxes and Axle-box Guides," by Mr. A. E. Kyffin. 7 p.m.

Royal Institute of British Architects.—9, Conduit-street, Regent-street, W. 1. Presidential address. 8.30 p.m.

SATURDAY, NOVEMBER 12TH.

Manchester Association of Engineers.—Memorial Hall, Albert-square, Manchester. "The Flow of Metal during Forging," by Mr. F. Massey. 7 p.m.

WEDNESDAY, NOVEMBER 16TH.

The Newcomen Society.—Caxton Hall, Westminster, S.W. Special general meeting. Paper on "The Liverpool and Manchester Railway" (illustrated by contemporary prints) by Mr. C. F. Dendy Marshall. 5 p.m.

FRIDAY, NOVEMBER 18TH, TO FRIDAY, NOVEMBER 25TH.

Public Works, Roads and Transport Congress, London. —For programme see page 422.

LAUNCHES AND TRIAL TRIPS.

El Deo; for carriage of petroleum in bulk; built by Sir W. G. Armstrong, Whitworth and Co., Limited, to the order of Lobitos Oilfields, Limited; to carry 9000 tons of oil and 800 tons of liquid fuel. Engines, triple-expansion, pressure 180 lb.; constructed by the builders; trial trip, Tuesday, September 20th.

Sophocles; twin-screw cargo and passenger vessel; built by Harland and Wolff, Limited, to the order of Geo. Thompson and Co., Limited; dimensions, 500ft. by 63ft. by 35ft. 3in.; gross tonnage, 12,300. Engines, two-shaft arrangement of the latest type of Brown-Curtis compound turbines; constructed by the builders; 150 first-class and 424 third-class passengers; launch, Thursday, September 22nd.

Pear Branch; built by Palmers Shipbuilding and Iron Company, Limited, to the order of Nautilus Steam Shipping Company, Limited; dimensions, 398ft. 6in. by 53ft. 8in. by 28ft. 3in.; to carry 7000 tons deadweight. Engines, double-reduction geared turbines of Parsons impulse and reaction type, pressure 200 lb.; constructed by the builders; trial trip, Monday, September 26th.

Moldavia; for mail, passenger and cargo service; built by Cammell Laird and Co., Limited, to the order of Peninsular and Oriental Steam Navigation Company; dimensions, 573ft. by 71½ft. by 51½ft.; to carry 222 first-class and 175 second-class passengers. Engines, twin-screw double reduction geared turbines; constructed by the builders; launch, Saturday, October 1st.

Rio Blanco; built by Blyth Shipbuilding and Dry Docks Company, Limited, to the order of Thompson Steam Shipping Company, Limited; dimensions, 377ft. by 53ft. 2½in. Engines, triple-expansion, 26in., 43in., 73in. by 48in. stroke; constructed by North-Eastern Marine Engineering Company, Limited; launch, Tuesday, October 4th.

Joseph Adlam; motor lifeboat; built by Royal National Lifeboat Institution, for its station at Blyth; dimensions, 43ft. by 12ft. 6in. Tyler engine developing 60 horse-power; trial trip, recently.

The Lady Clifford; built by Lobnitz and Co., Limited, to the order of Crown Agents for the Colonies; to carry 4200 tons; trial trip, recently.

Lantern Slides for Lecture Purposes.—Ed. Bennis and Co., Limited, 28, Victoria-street, Westminster, London, S.W. 1, ask us to state that they have a large number of lantern slides available for lecture purposes. The slides cover the whole field of development in connection with mechanical stokers and coal and ash-elevating and conveying plant. A booklet giving the titles and a brief description of the slides will be sent to any inquirers on request.

The "Archibald Dawnay" Scholarship in Civil Engineering.—The announcement was recently made of the institution of the "Archibald Dawnay" Scholarship in Civil Engineering, from moneys bequeathed by Sir Archibald Dawnay to the London County Council. For the present one scholarship will be awarded annually, tenable as a rule for three years in the Civil Engineering Course at the Battersea Polytechnic, the Finsbury Technical College or the Northampton Polytechnic. Additional institutions at which the scholarships may be held may be approved in future as additional scholarships are awarded. At the present time the scholarship is of the value of £110 a year, the student being required to pay for his tuition, books, &c. The general conditions of award are similar to those for the Council's Senior Science Scholarships, *e.g.*, candidates' parents must be ordinarily resident in the County of London, and their income must not generally exceed £750 a year. The first scholarship under the scheme has recently been awarded to a student who, starting his studies at an elementary school, subsequently proceeded to a secondary school by means of a county scholarship. With the aid of the "Archibald Dawnay" Scholarship he will now be able to concentrate on the study of civil engineering. The next award will be made about May, 1922, and applications should be addressed to the Education Officer (T.2a), New County Hall, S.E. 1. Further announcements on the subject will be made during March and April next.